Group meeting
June 14th, 2024

Instruction responsibilities

- Classes for Fall 2024:
  - PHY 331:
    - Need to make syllabus
  - PHY 361:
    - Need to make syllabus

Service responsibilities

- Committee:
  - GlueX Compton Analysis Review Committee:
    - Waiting for author response

Group responsibilities

- Undergrad: Worked with Dylan on Tuesday

Analysis

Presentations:

- None

KKpi analysis:

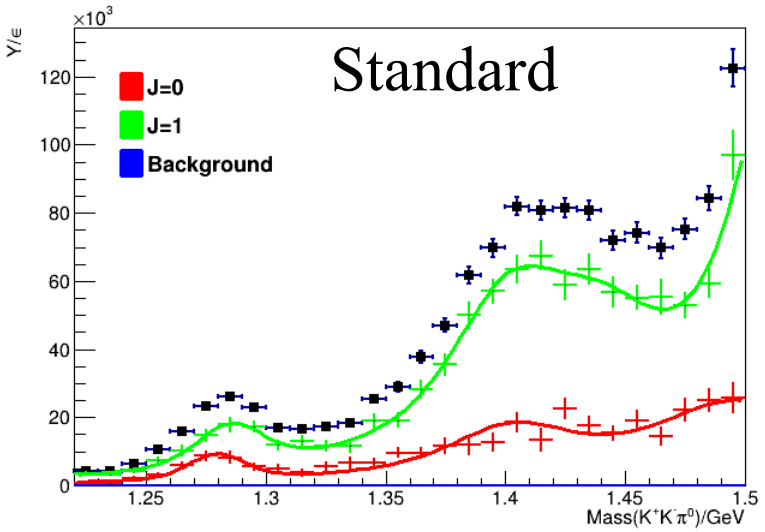
- Polarization setup in progress

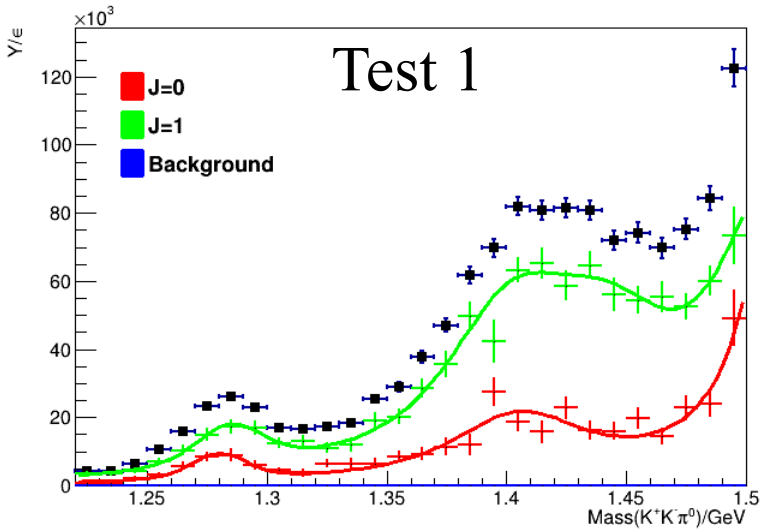
Ξ^* analysis:

- Vertex analysis

$KK\pi$ Polarization Setup

Test 1





- Standard was run prior to separation of files based on polarization
- Test 1:
  - Separation of files based on polarizations
  - Run through stage2, stage2Q, chop (performs E_γ cut)
  - Added back together and run through PWA

Test 1: Passed ☺

Test 2

Test 2:

- Process the four polarization files as different reactions within the AmpTools framework

Test 2 is not going well ☹

- Jobs are taking a very long time to complete
- 8 failed jobs
- 2 dead nodes

Decided to kill the rest ☹

Bump hunt part II

Reaction

$$\gamma\, p \rightarrow K^{+} K^{+} \Xi^{-} \pi^{0}$$

Reaction

$$\gamma\, p \rightarrow K^{+}K^{+}\Xi^{-}\pi^{0},$$

where $\Xi^{-} \rightarrow \Lambda\pi^{-}$

Reaction

$$\gamma\, p \rightarrow K^{+}K^{+}\Xi^{-}\pi^{0},$$

where $\Xi^{-} \rightarrow \Lambda\pi^{-}$

and $\Lambda \rightarrow p\pi^{-}$

Reaction

$$\gamma\, p \rightarrow K^{+}K^{+}\Xi^{-}\pi^{0},$$

where $\Xi^{-} \rightarrow \Lambda\pi^{-}$

and $\Lambda \rightarrow p\pi^{-}$

- Mass of Ξ^{-} not constrained

IMPORTANT POINT

- At this point, I am looking for interesting bumps
- Any mass[$\Xi\pi$] bump, other than the $\Xi^*(1530)$, is to be taken as merely suggestive

$\Xi(1620)$: From 1-star

Nucleon resonances are rated using the "star" system:

* Poor evidence of existence

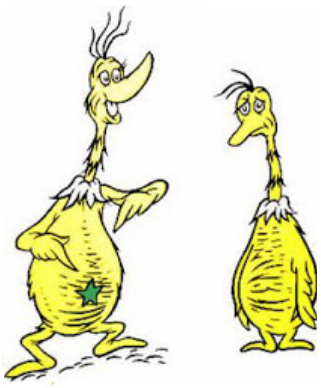
$\Xi(1620)$ $I(J^P) = \frac{1}{2}(?^?)$ Status: *
J, P need confirmation.

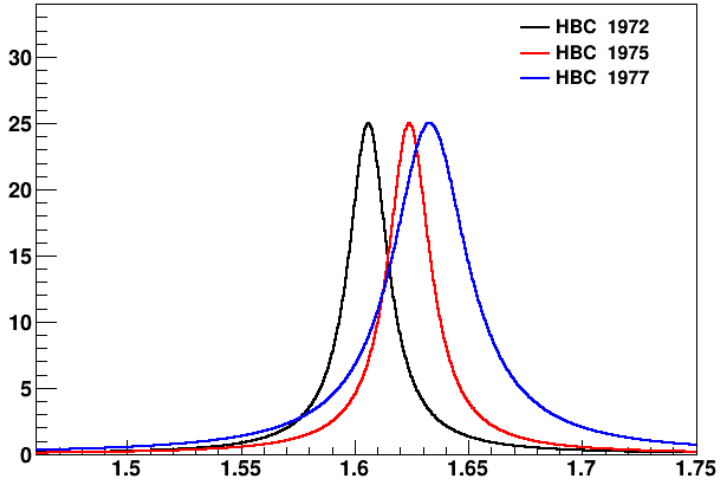
OMITTED FROM SUMMARY TABLE

What little evidence there is consists of weak signals in the $\Xi\pi$ channel. A number of other experiments (e.g., BORENSTEIN 72 and HASSALL 81) have looked for but not seen any effect.

$\Xi(1620)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
≈ 1620 OUR ESTIMATE					
1624± 3	31	BRIEFEL	77	HBC	$K^- p$ 2.87 GeV/c
1633±12	34	DEBELLEFON	75B	HBC	$K^- p \to \Xi^- \overline{K}\pi$
1606± 6	29	ROSS	72	HBC	$K^- p$ 3.1–3.7 GeV/c





$\Xi(1620)$: From 1-star to 2-star

Nucleon resonances are rated using the "star" system:

* Poor evidence of existence

** Fair evidence of existence

$\Xi(1620)$ $I(J^P) = \frac{1}{2}(?^?)$ Status: *

J, *P* need confirmation.

OMITTED FROM SUMMARY TABLE

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Citation: S. Navas *et al.* (Particle Data Group), Phys. Rev. D **110**, 030001 (2024)

$\Xi(1620)$ $I(J^P) = \frac{1}{2}(?^?)$ Status: **

J, *P* need confirmation.

OMITTED FROM SUMMARY TABLE

The clearest evidence is a peak in $\Xi^-\pi^+$ seen by SUMIHAMA 19. Older low-statistics experiments (e.g., BORENSTEIN 72 and HASSALL 81) have looked for the state but have not seen any effect.

$\Xi(1620)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
≈ 1620 OUR ESTIMATE					
$1610.4 \pm 6.0^{+6.1}_{-4.2}$		SUMIHAMA	19	BELL	$\Xi_c^+ \to \Xi(1620)\pi^+$
1624 ± 3	31	BRIEFEL	77	HBC	$K^- p$ 2.87 GeV/c
1633 ±12	34	DEBELLEFON	75B	HBC	$K^- p \to \Xi^- \overline{K}\pi$
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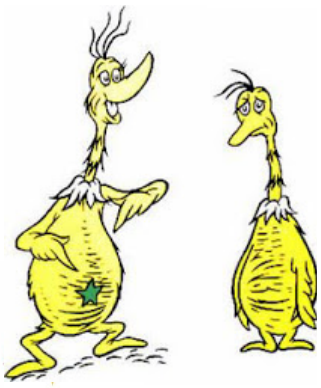
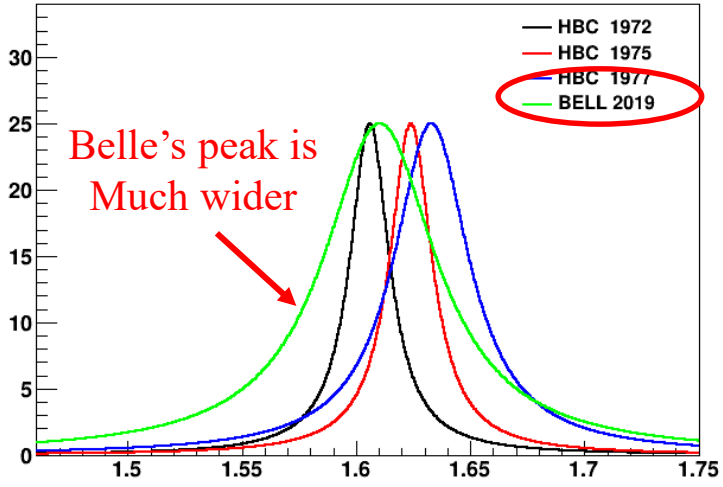
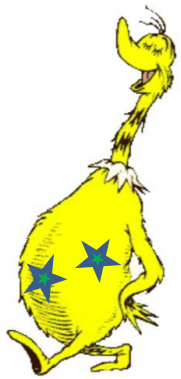
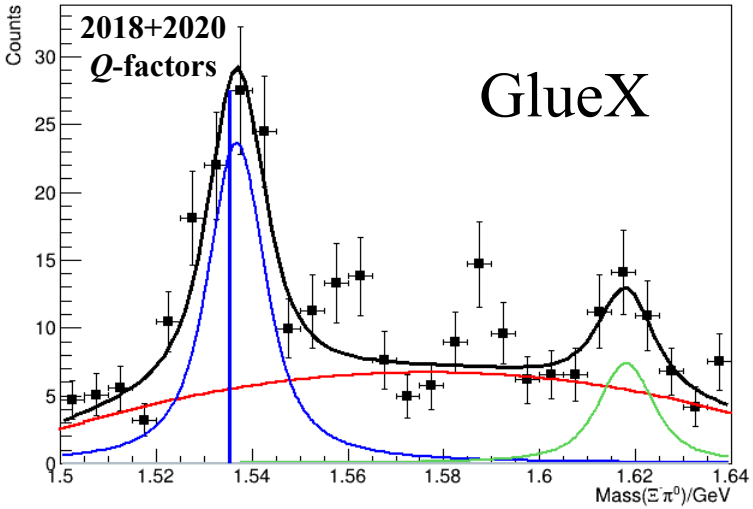


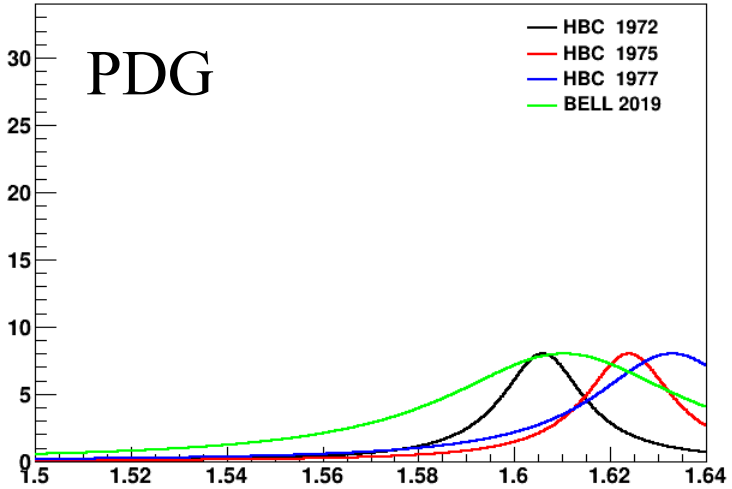




Assumed bump structure, compared to PDG

Narrow bump

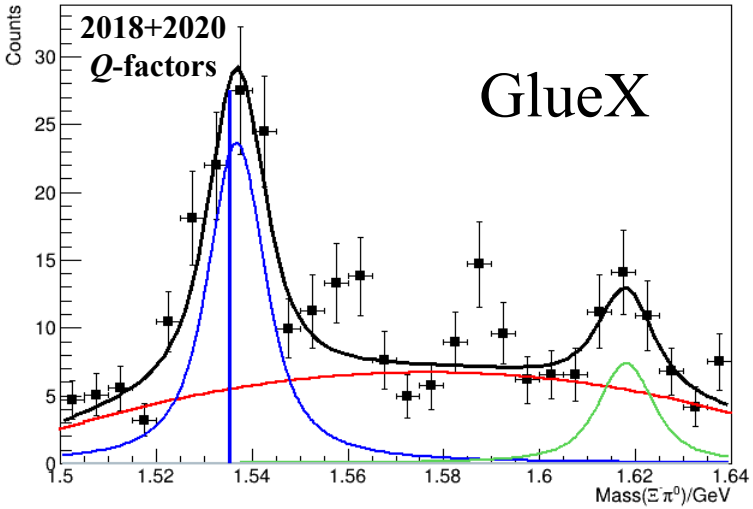


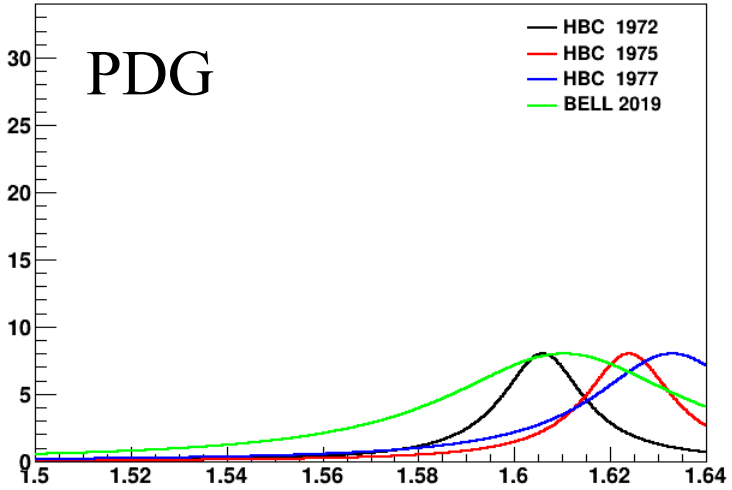


Wide bump

Assumed bump structure, compared to PDG

Narrow bump





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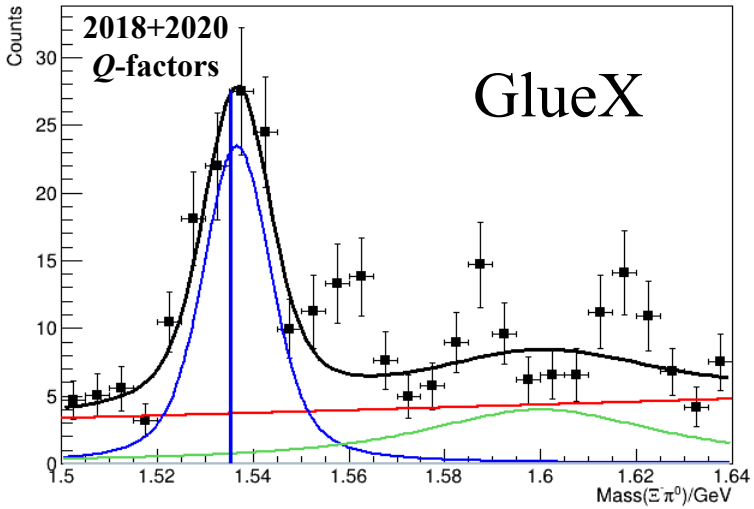

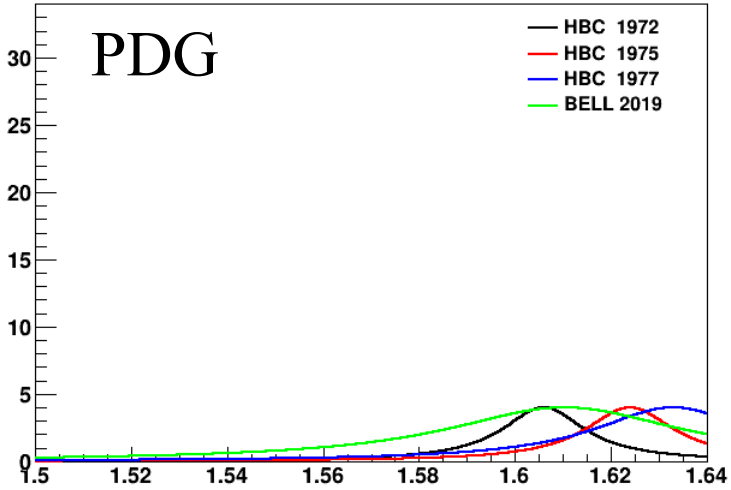

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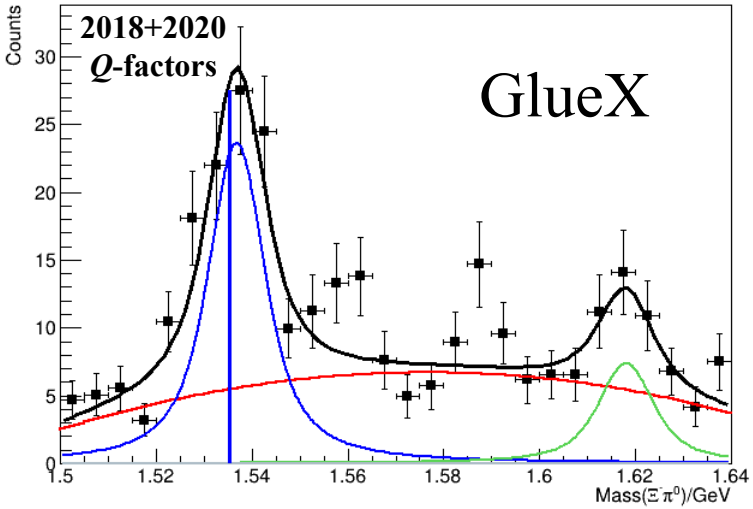

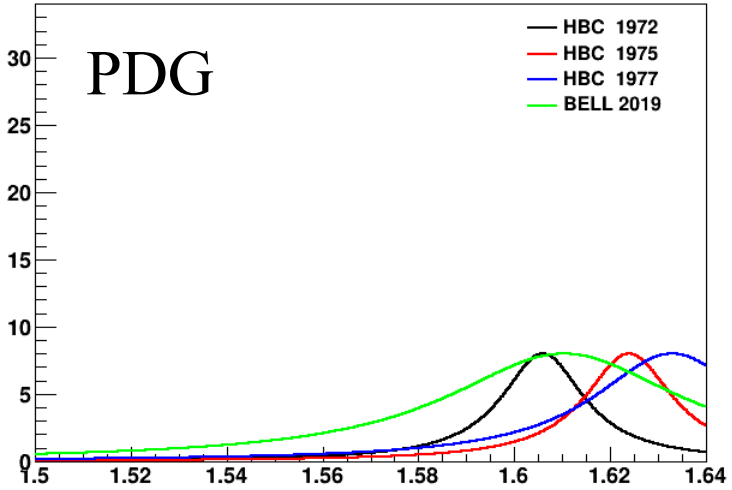

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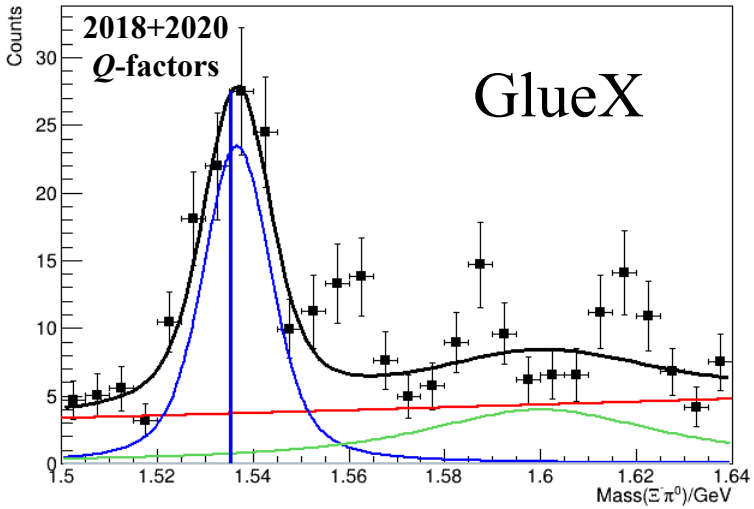
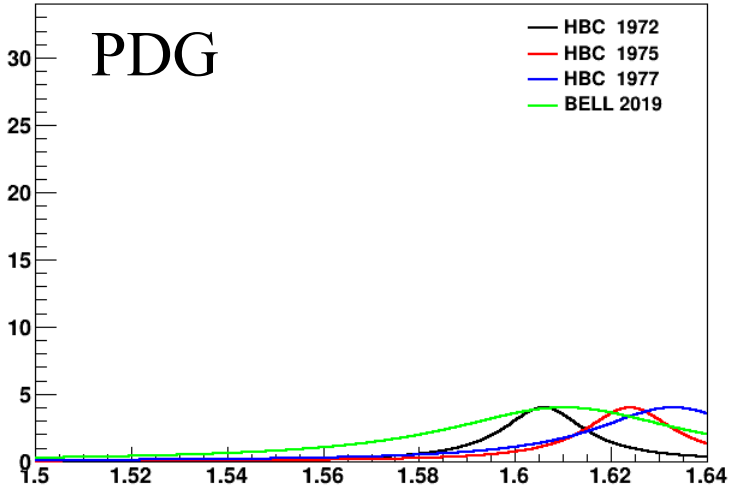




- Perhaps *Q*-factors were implemented incorrectly ☹

Assumed bump structure, compared to Belle

Target shoot Belle:

Assumed bump structure, compared to Belle

Target shoot Belle:

- Changing CL cut to CL>10^{-4}

Assumed bump structure, compared to Belle

Target shoot Belle:

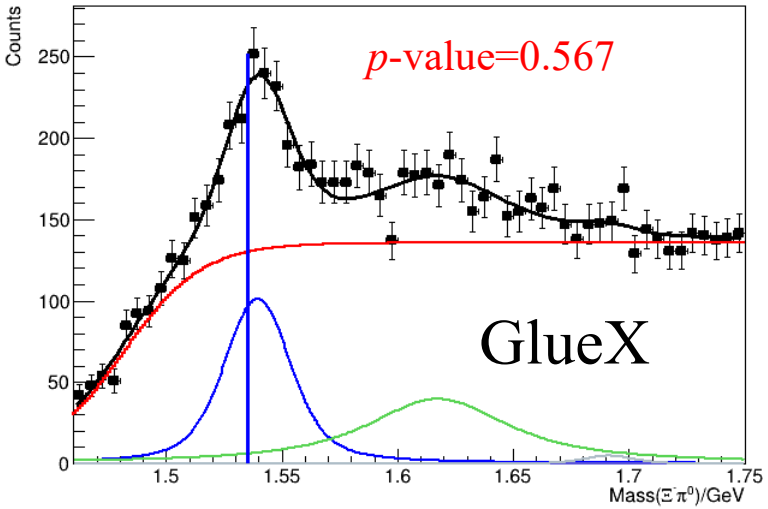
- Changing CL cut to CL>10^{-4}
- Removing *Q*-factors

Assumed bump structure, compared to Belle

Target shoot Belle:

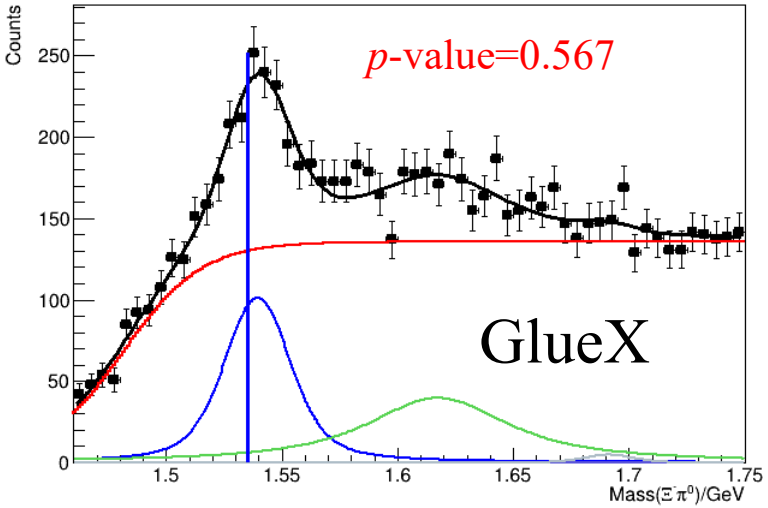
- Changing CL cut to CL>10^{-2}
- Removing *Q*-factors
- Change fit range to match that of Belle

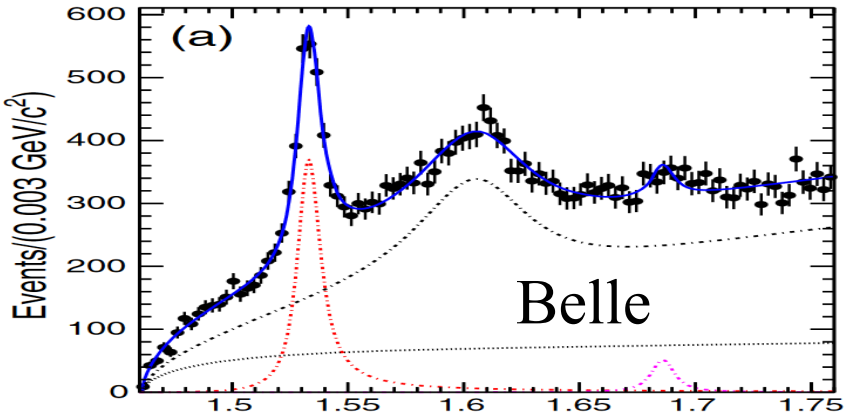
Assumed bump structure, compared to Belle



Background (red) :
[First order polynomial]*[sigmoid]

Assumed bump structure, compared to Belle





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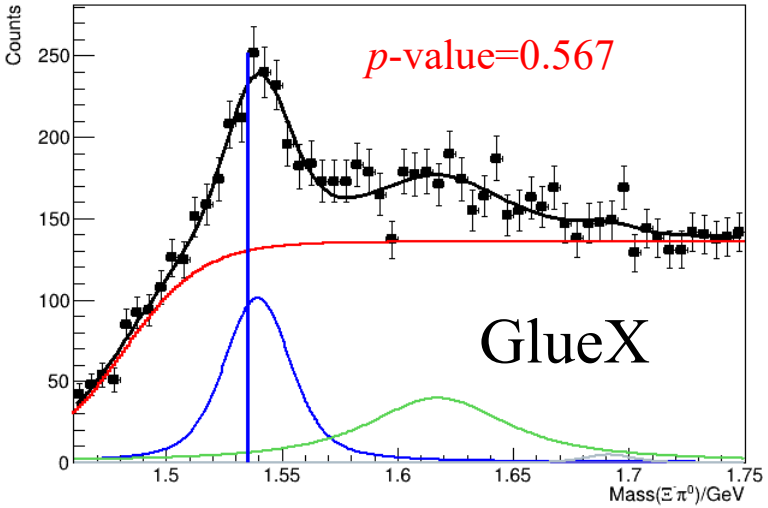
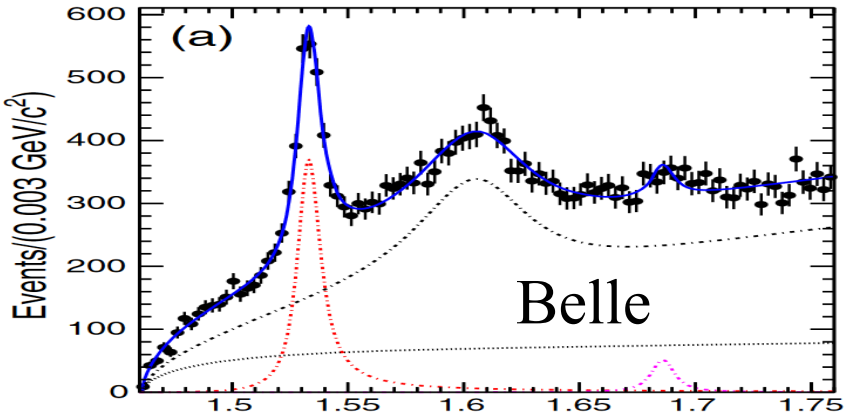
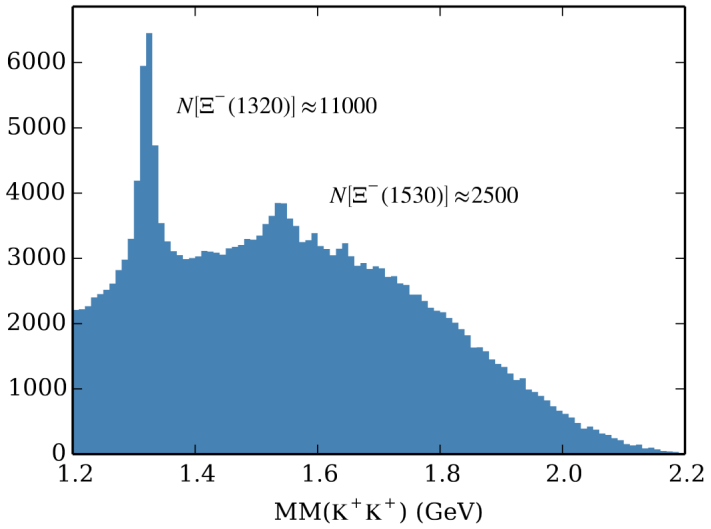




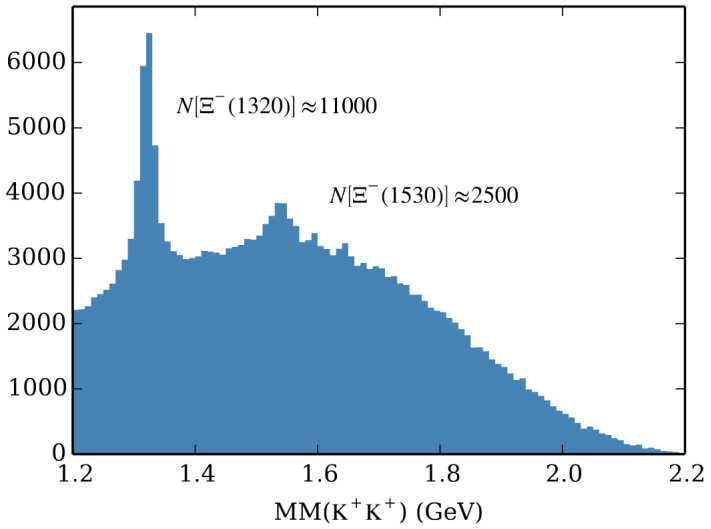
- Looks reasonable ☺

CLAS Ξ and $\Xi(1530)$



- Reaction: $\gamma\, p \rightarrow K^+\, K^+\, X$

CLAS Ξ and $\Xi(1530)$



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- Here, X represent the missing particle(s)

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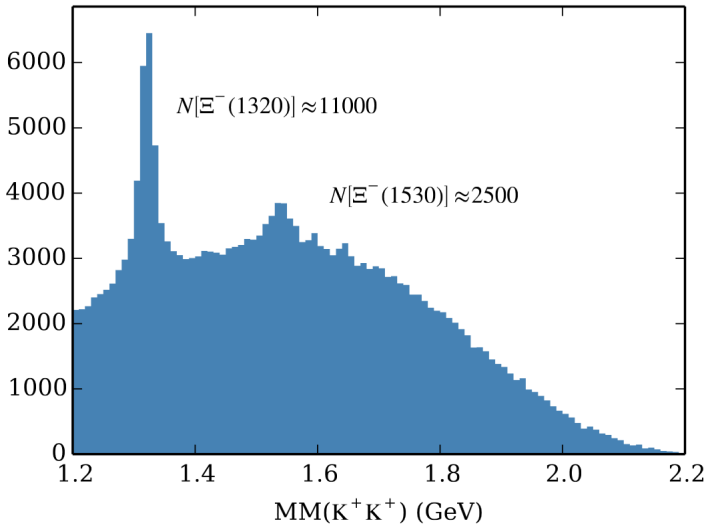
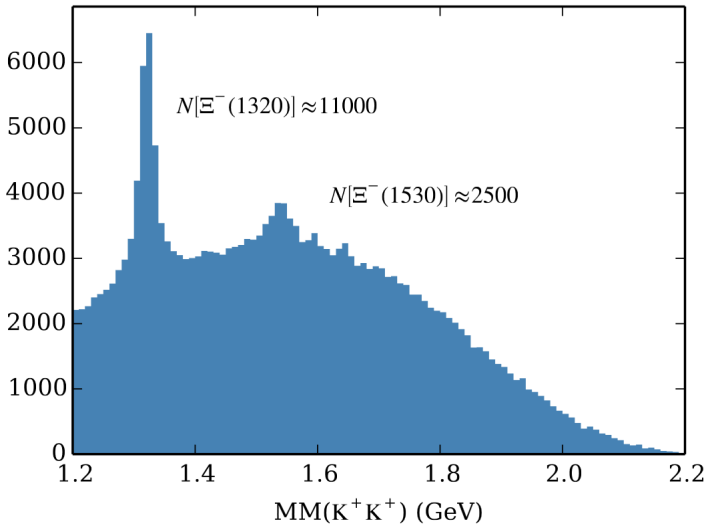


- Reaction: $\gamma\, p \rightarrow K^+\, K^+\, X$
- Here, X represent the missing particle(s)
- Ostensibly, X is Ξ^- or Ξ^{-*}
  - from $\gamma\, p \rightarrow K^+\, Y^*$, where $Y^* \rightarrow K^+\, \Xi^-$

CLAS Ξ and $\Xi(1530)$



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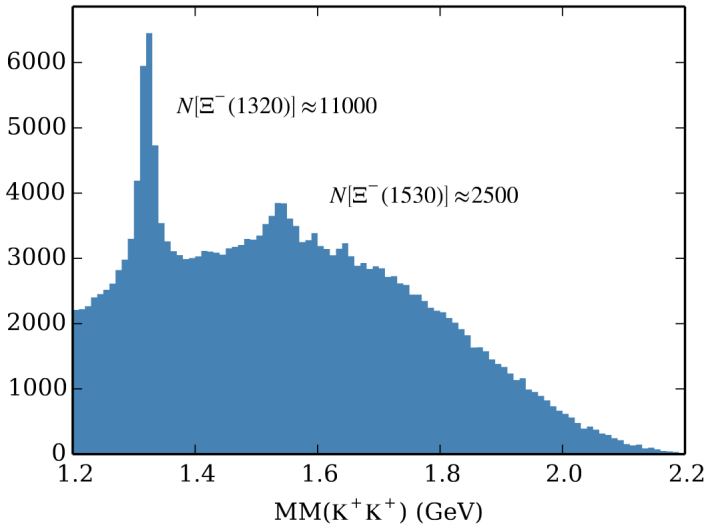
- $E_\gamma < 5.4$ GeV

CLAS Ξ and $\Xi(1530)$



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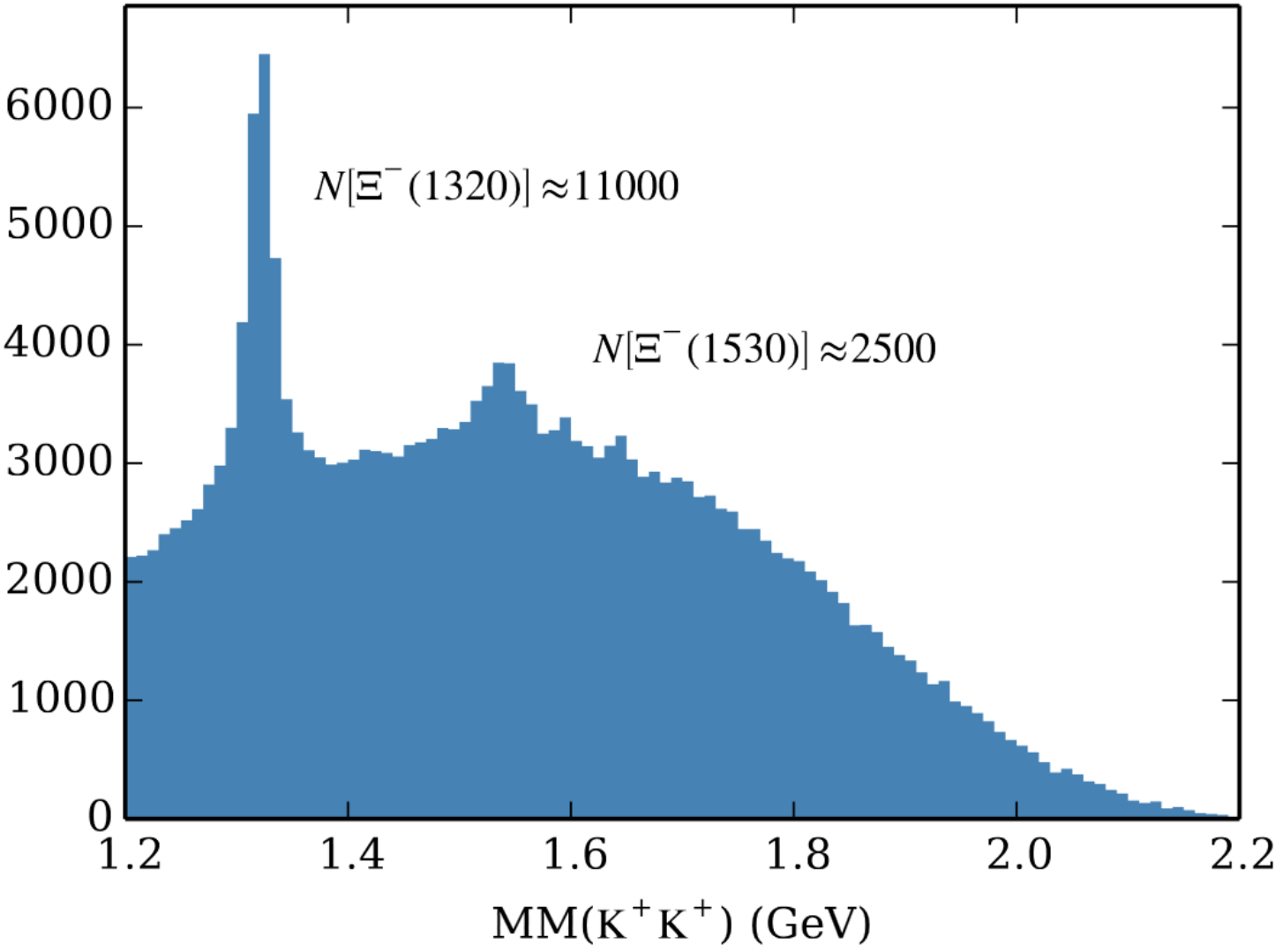
- $E_\gamma < 5.4$ GeV

- A lot of background from many types of final states
  - $\gamma\, p \rightarrow K^+\, K^+\, X$ is very inclusive of Ξ^{-*} type states with decays NOT limited to
    - $\Xi\pi$
    - $\Xi^*\pi$
    - ΛK
    - $K\Sigma$
    - or ?

CLAS comparison



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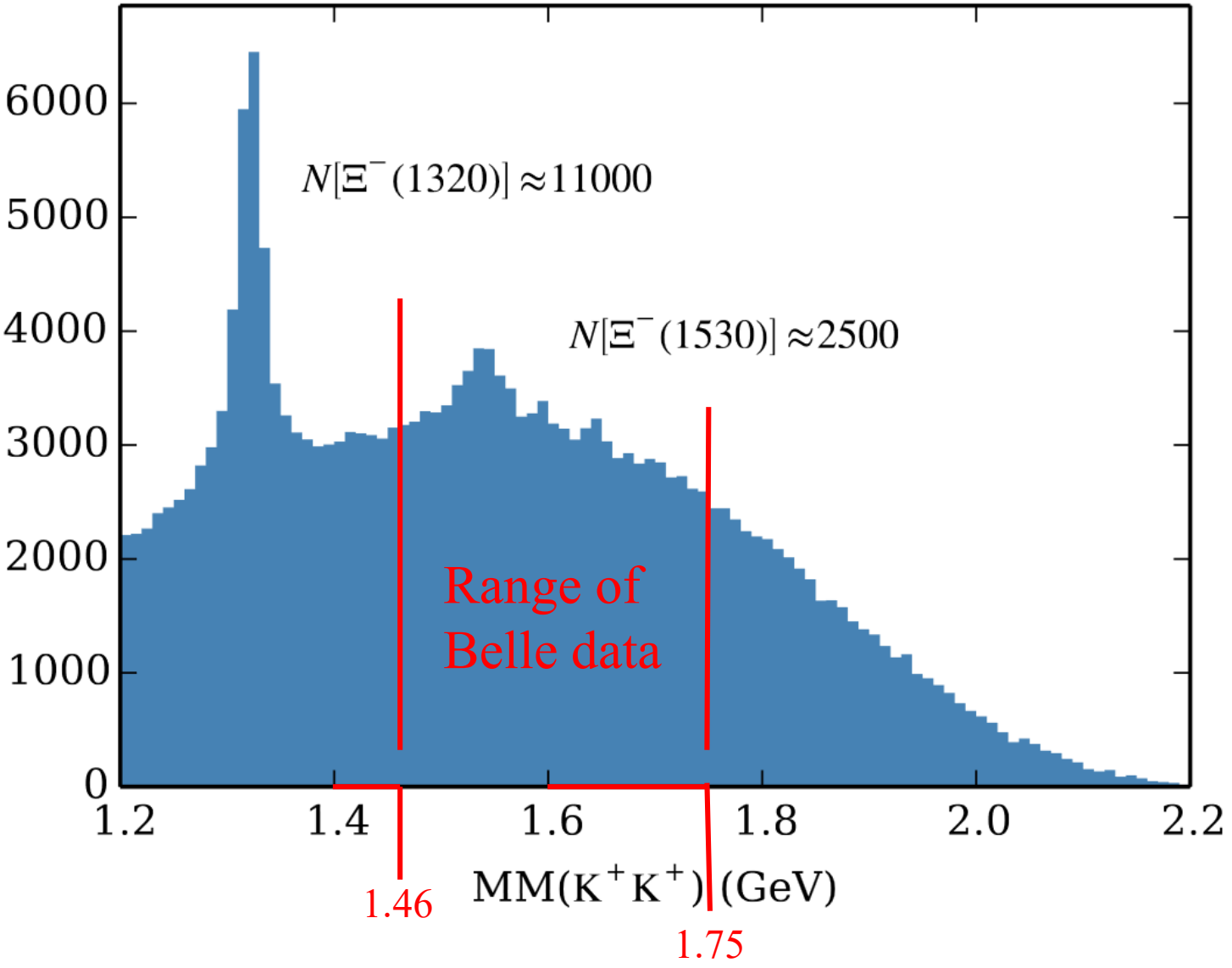

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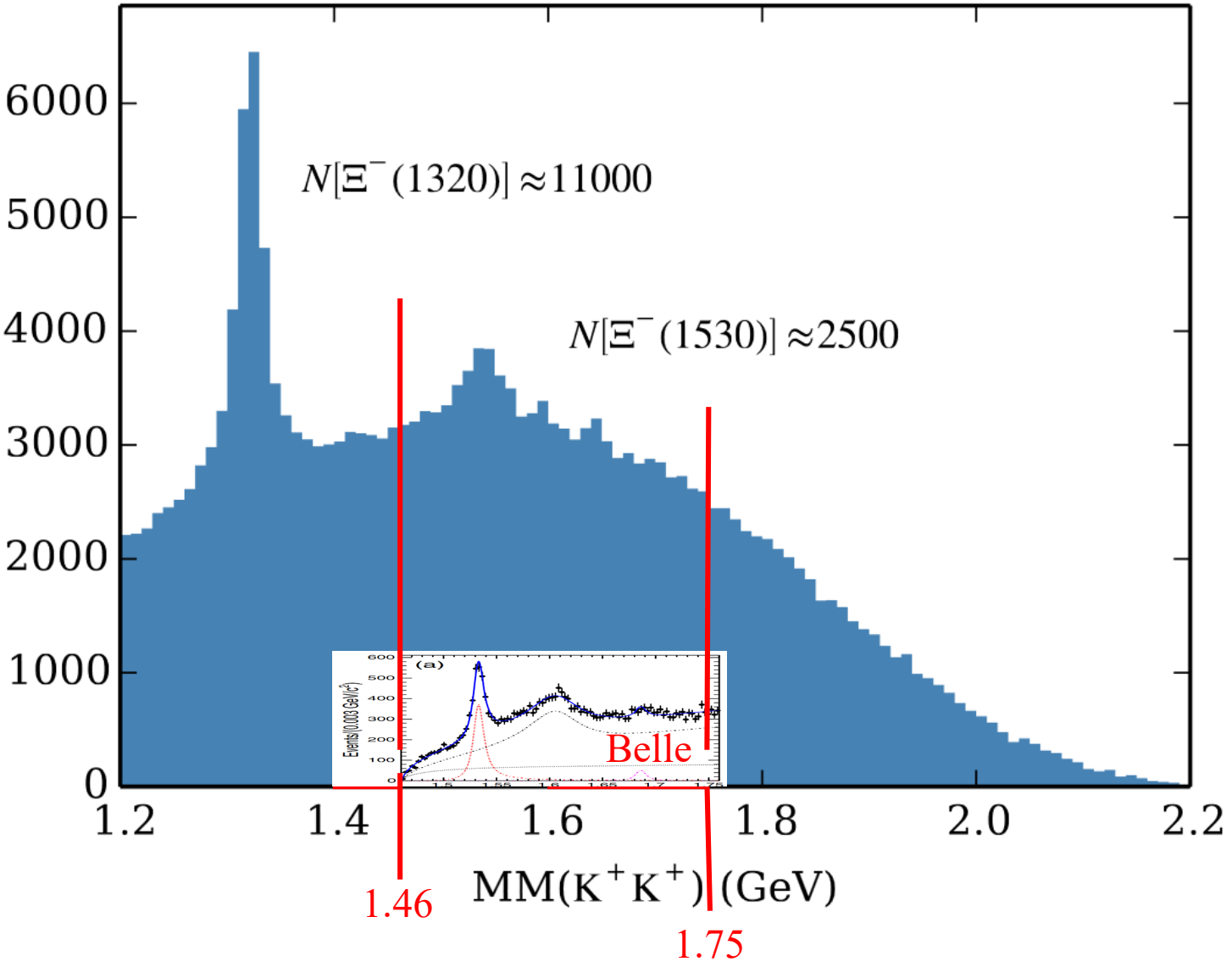

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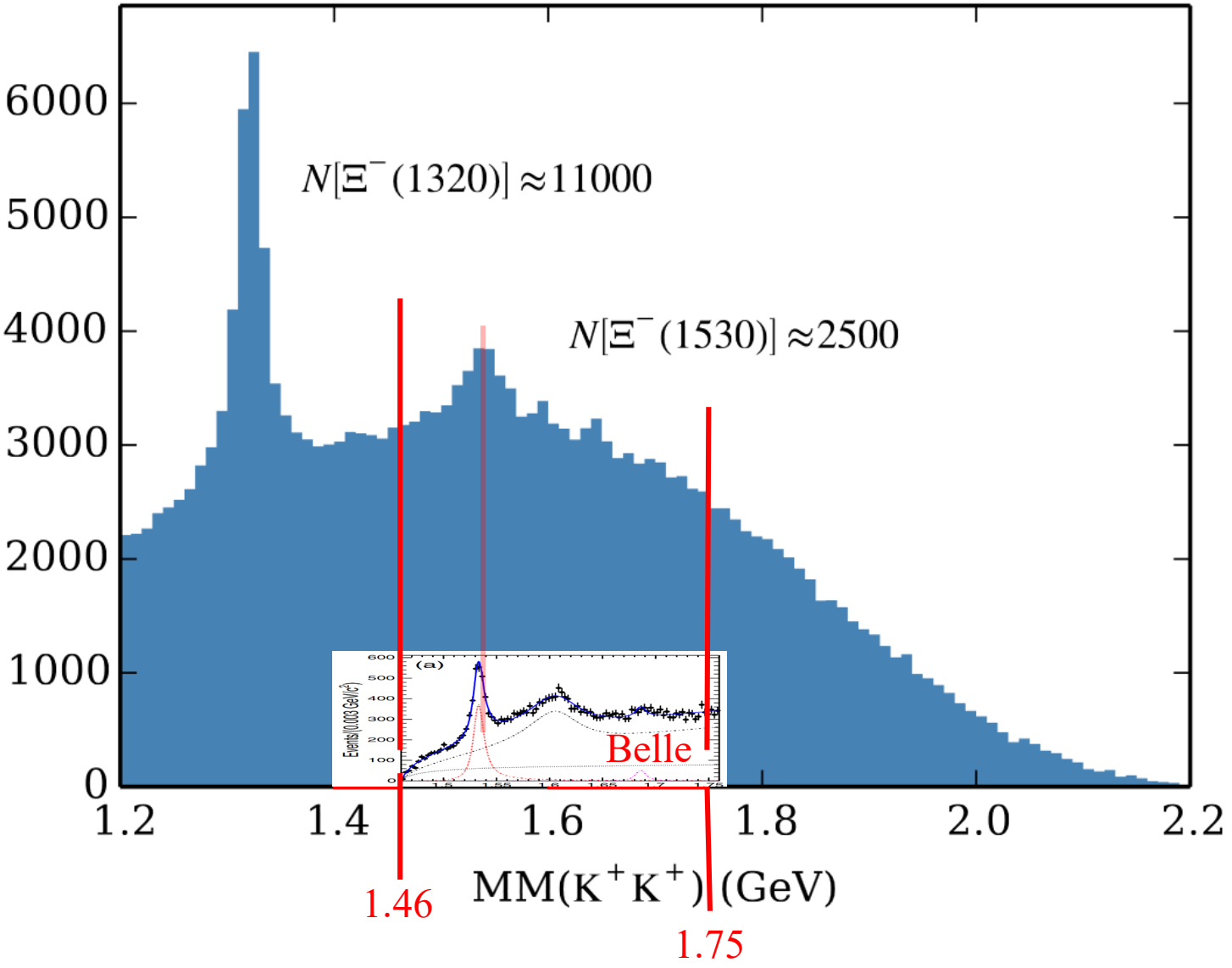

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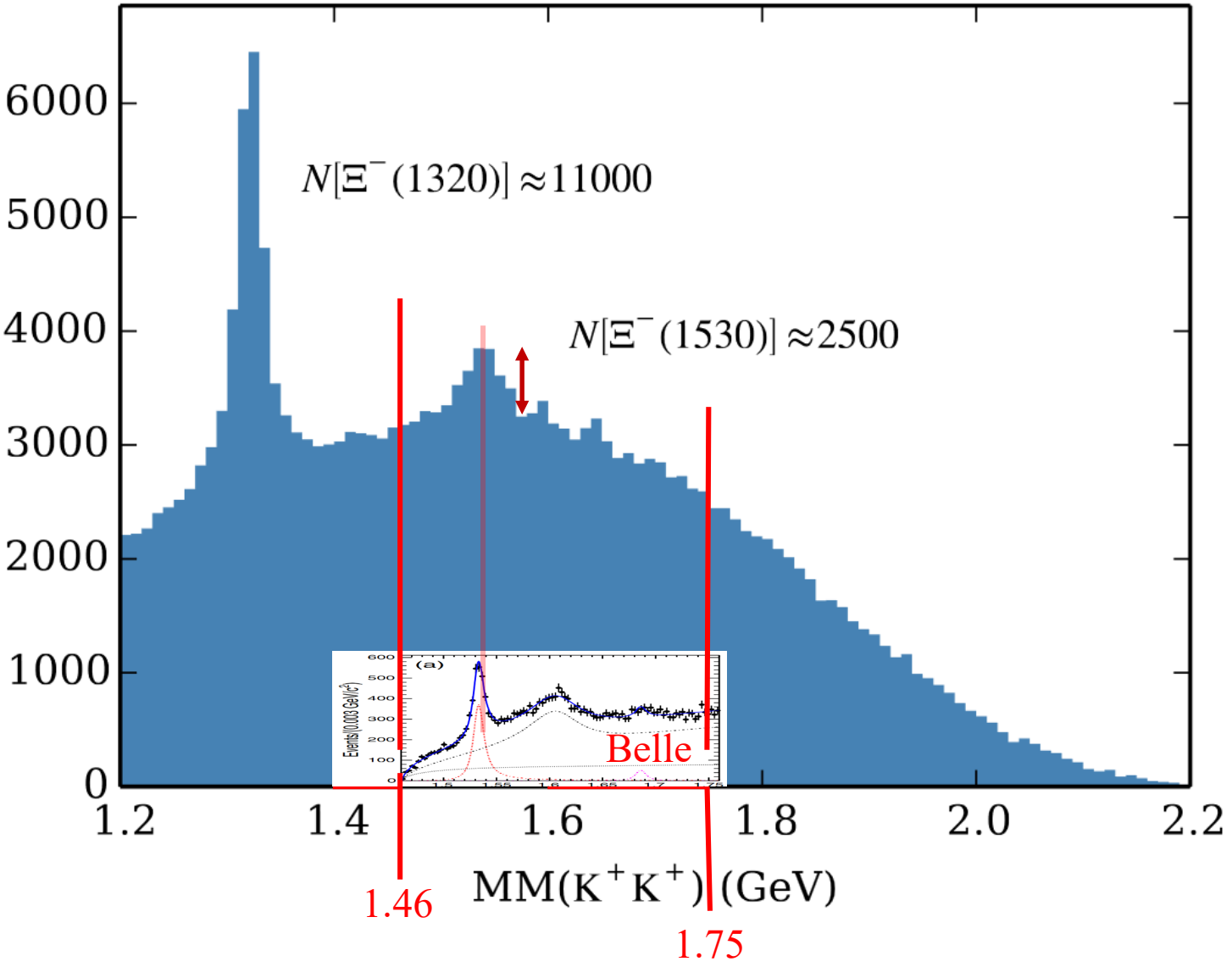

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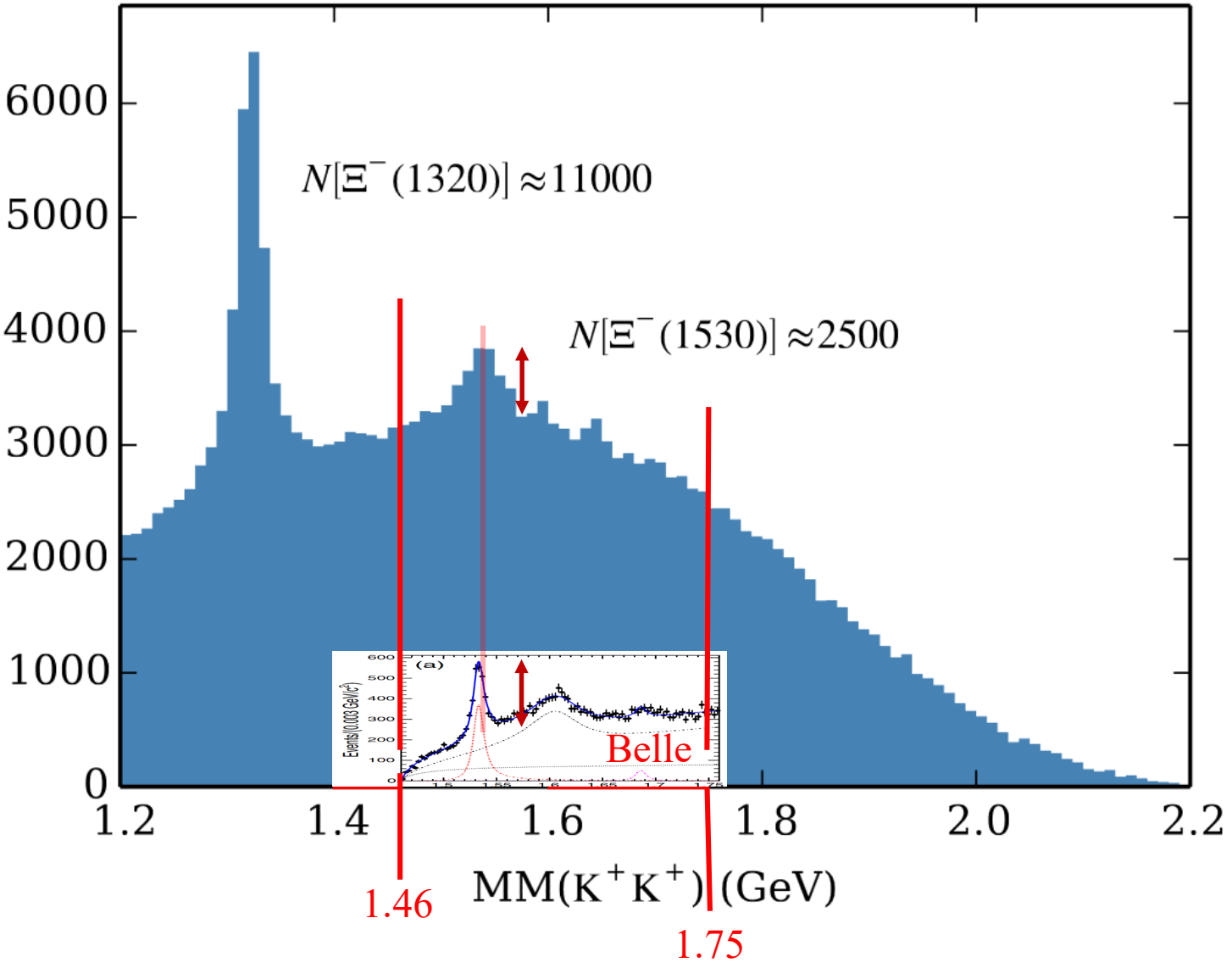

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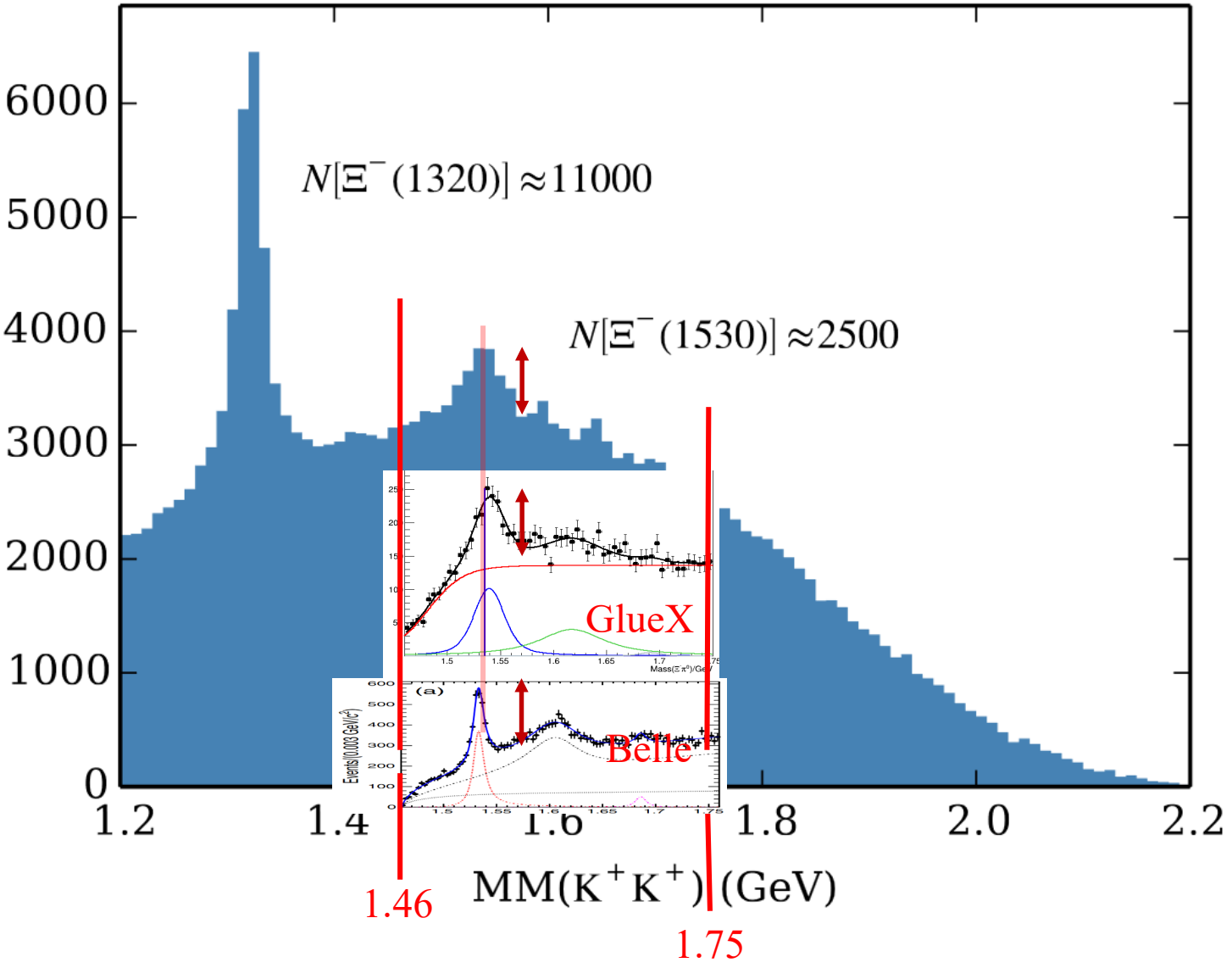

Reaction

$$\gamma p \rightarrow K^+K^+\Xi^-\pi^0,$$

where $\Xi^- \rightarrow \Lambda\pi^-$

and $\Lambda \rightarrow p\pi^-$

- Mass of Ξ^- not constrained
- The Ξ^- has a long lifetime

Ξ^- MEAN LIFE

Measurements with an error > 0.2×10^{-10} s or with systematic errors not included have been omitted.

VALUE (10^{-10} s)	EVTS	DOCUMENT ID		TECN	COMMENT
1.639±0.015 OUR AVERAGE					
1.65 ±0.07 ±0.12	2478 ± 68	ABDALLAH	06E	DLPH	from Z decays
1.652±0.051	32k	BOURQUIN	84	SPEC	Hyperon beam
1.665±0.065	41k	BOURQUIN	79	SPEC	Hyperon beam
1.609±0.028	4286	HEMINGWAY	78	HBC	4.2 GeV/c K^-p
1.67 ±0.08		DIBIANCA	75	DBC	4.9 GeV/c K^-d
1.63 ±0.03	4303	BALTAY	74	HBC	1.75 GeV/c K^-p
$1.73\ ^{+0.08}_{-0.07}$	680	MAYEUR	72	HLBC	2.1 GeV/c K^-
1.61 ±0.04	2610	DAUBER	69	HBC	
1.80 ±0.16	299	LONDON	66	HBC	
1.70 ±0.12	246	PJERROU	65B	HBC	
1.69 ±0.07	794	HUBBARD	64	HBC	
$1.86\ ^{+0.15}_{-0.14}$	517	JAUNEAU	63D	FBC	

Reaction

$$\gamma p \rightarrow K^+K^+\Xi^-\pi^0,$$

where $\Xi^- \rightarrow \Lambda\pi^-$

and $\Lambda \rightarrow p\pi^-$

- Mass of Ξ^- not constrained
- The Ξ^- has a long lifetime
  - Can cut on ΔVertex

Ξ^- MEAN LIFE

Measurements with an error > 0.2×10^{-10} s or with systematic errors not included have been omitted.

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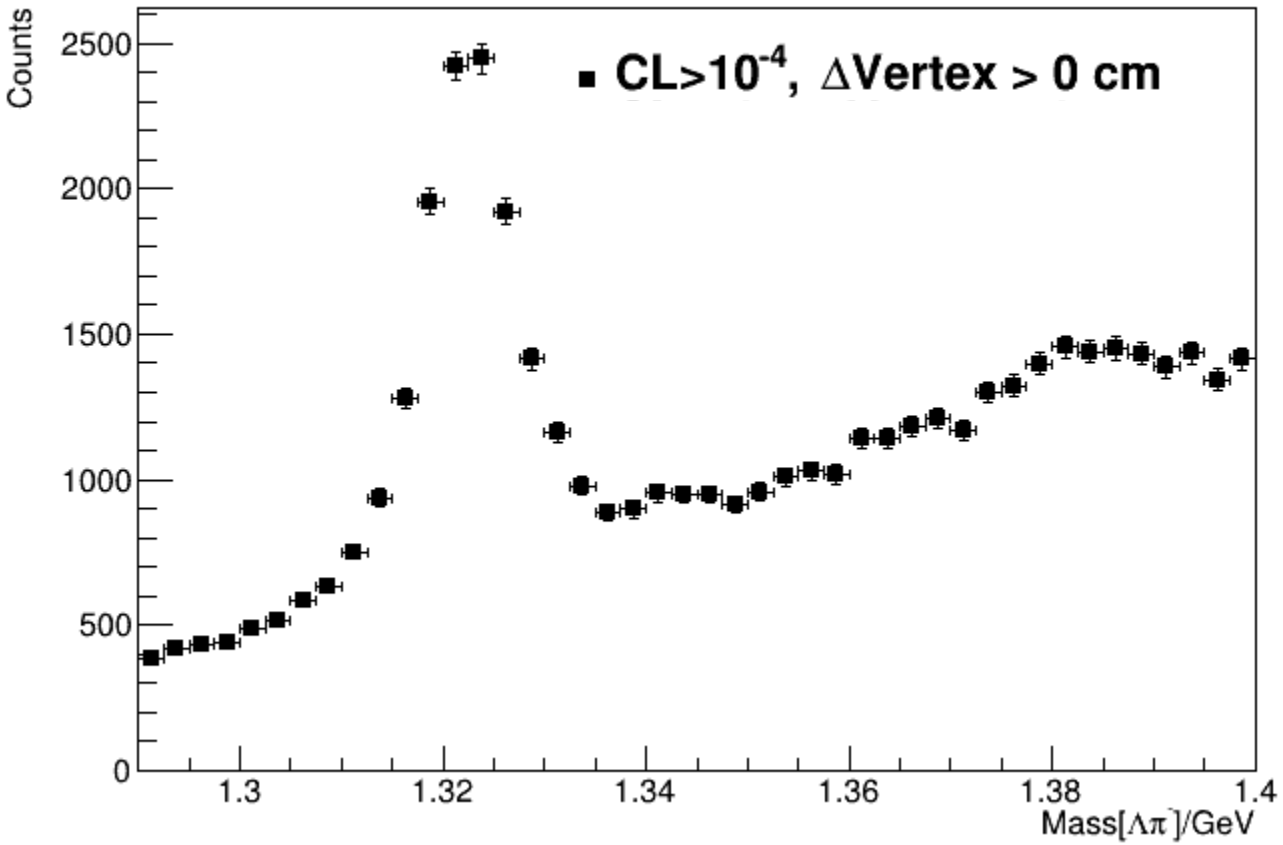
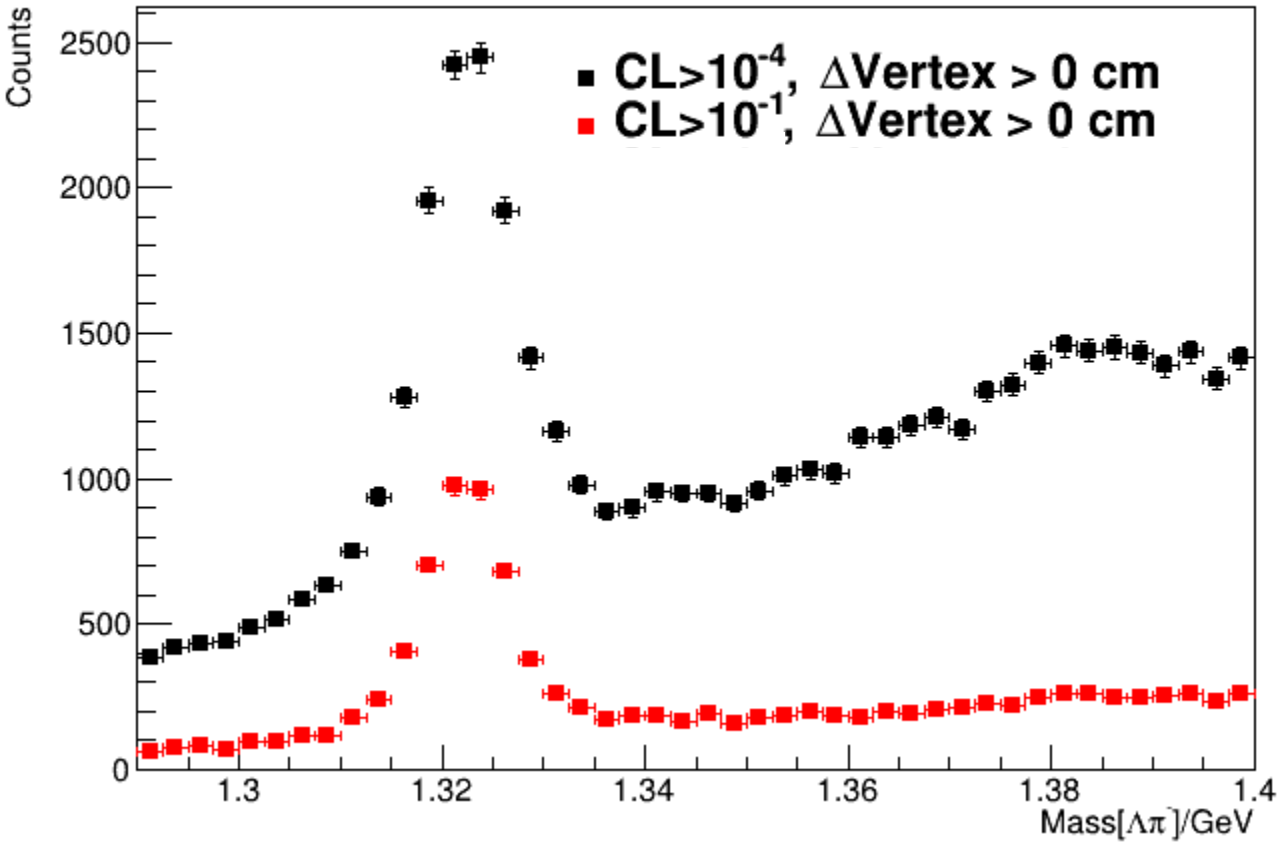
ΔVertex cut

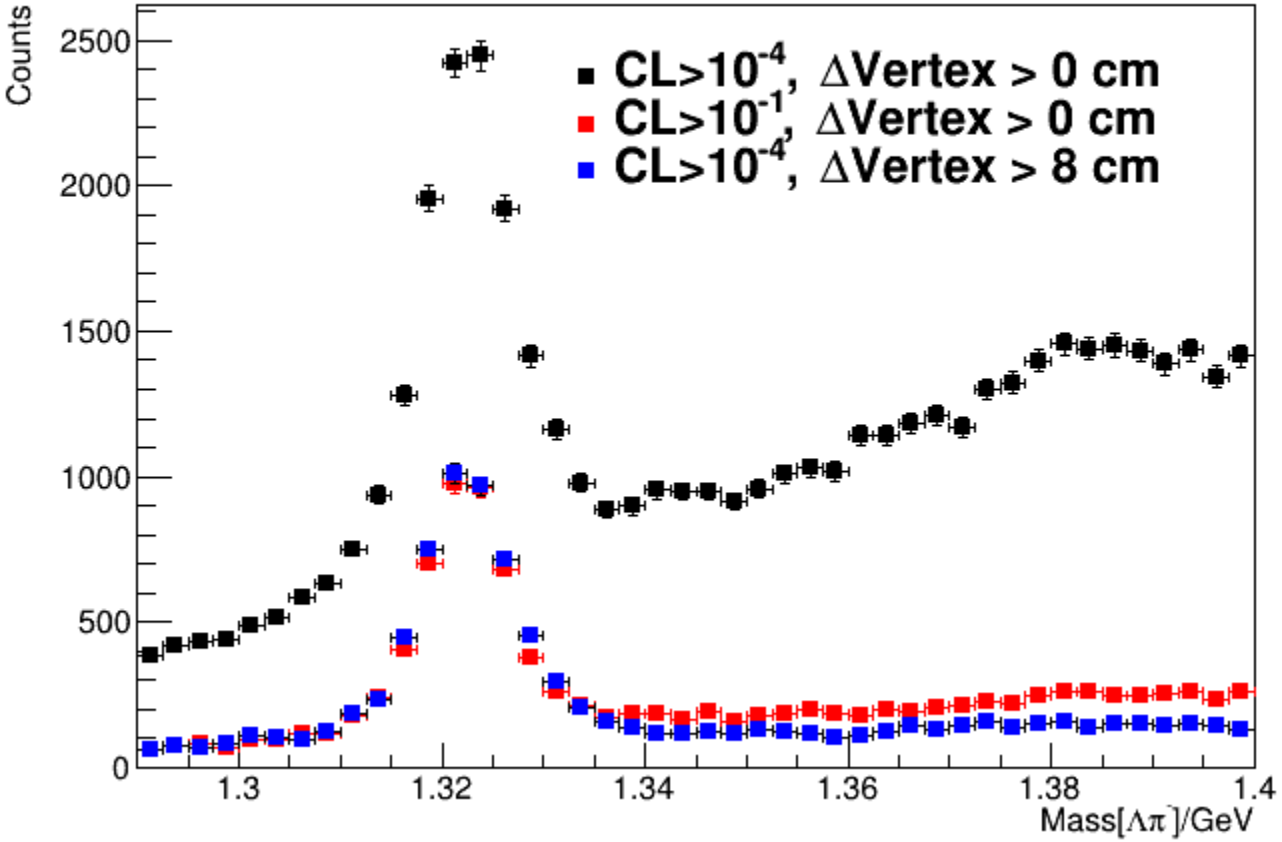
ΔVertex cut


Counts
2500
2000
1500
1000
500
0
1.3
1.32
1.34
1.36
1.38
1.4
Mass[Λπ⁻]/GeV
CL>10⁻⁴, ΔVertex > 0 cm

ΔVertex cut

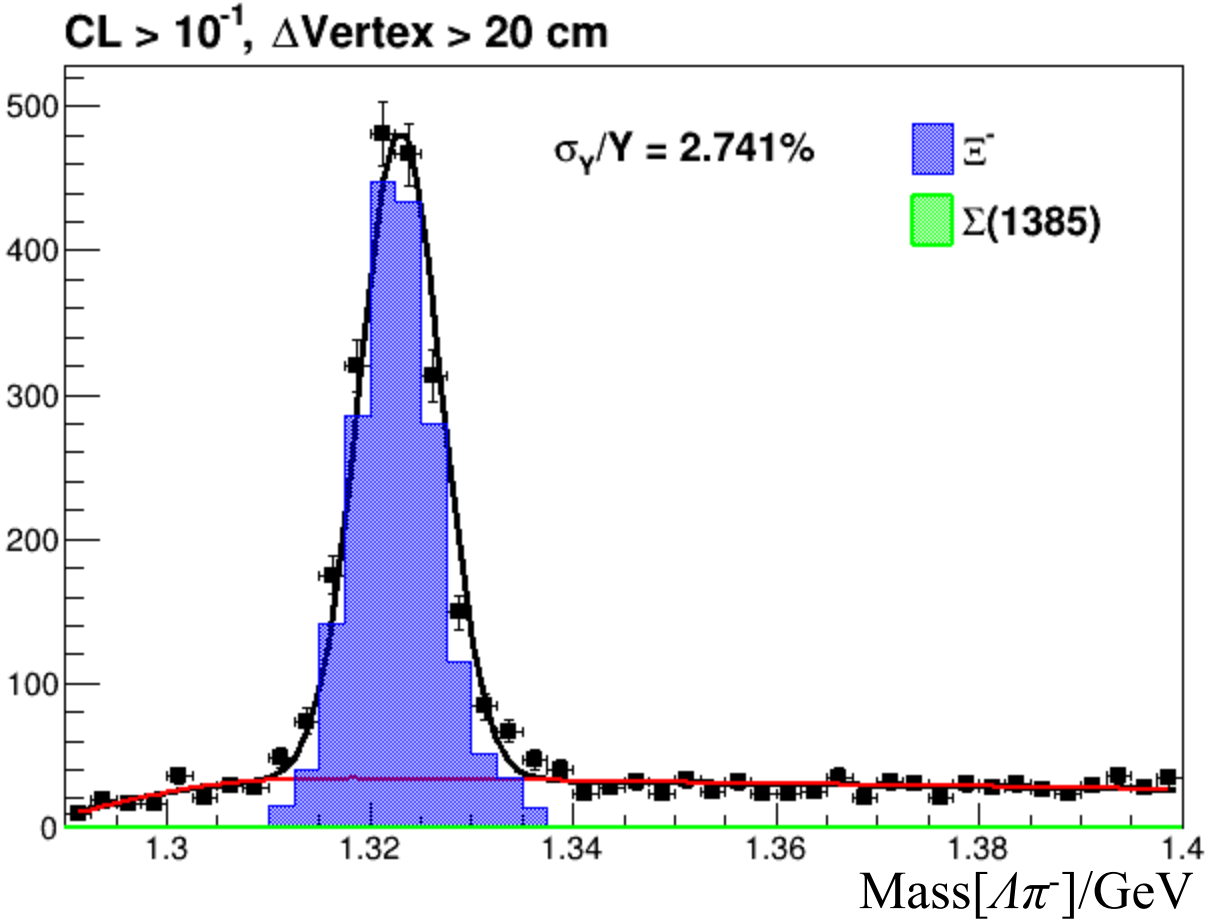

Counts
2500
2000
1500
1000
500
0
1.3
1.32
1.34
1.36
1.38
1.4
Mass[Λπ⁻]/GeV
CL>10⁻⁴, ΔVertex > 0 cm
CL>10⁻¹, ΔVertex > 0 cm

ΔVertex cut

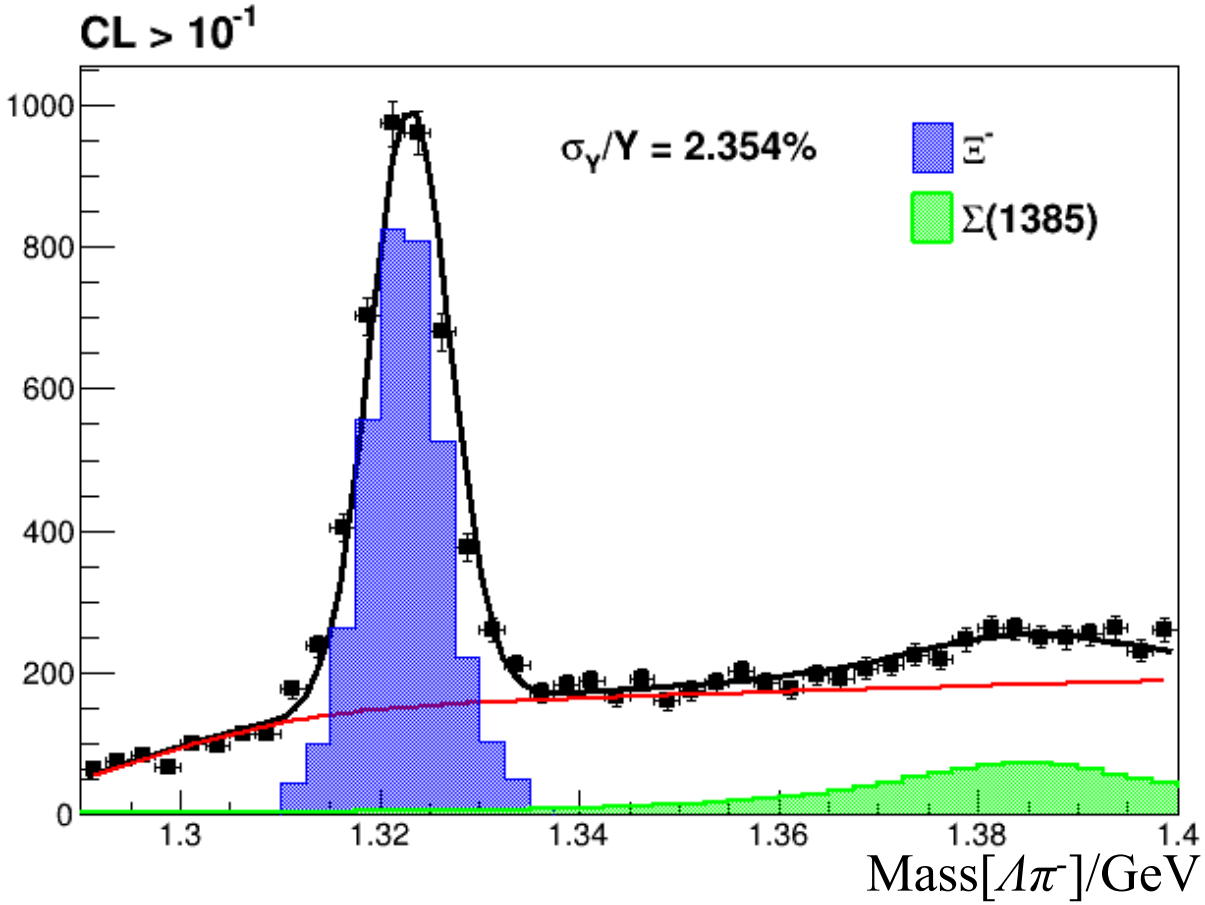


- Different combinations of CL and ΔVertex cuts can yield very similar results

ΔVertex cut

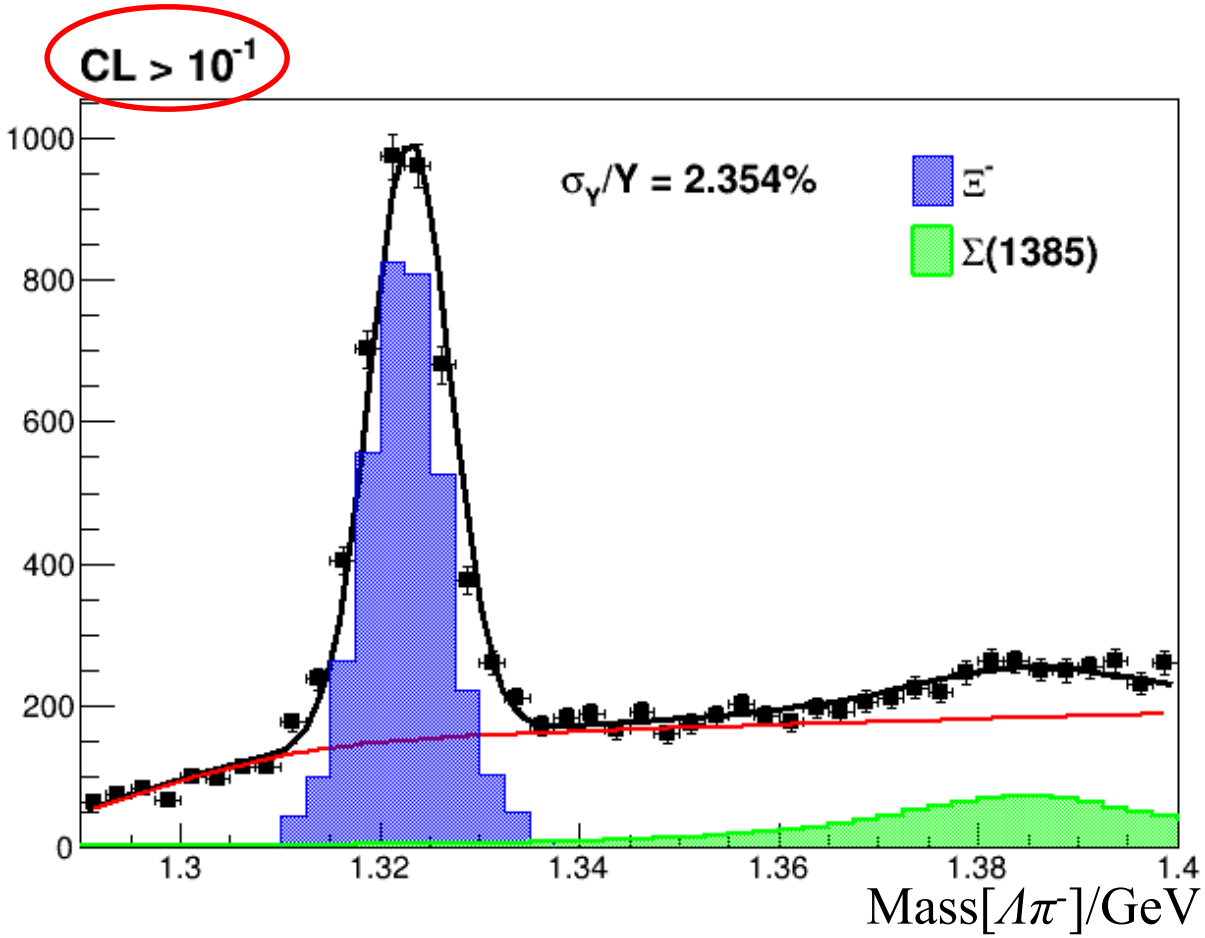


- With vertex cut, the Ξ signal can become very clean!
- Need to study different vertex cuts with different CL cuts



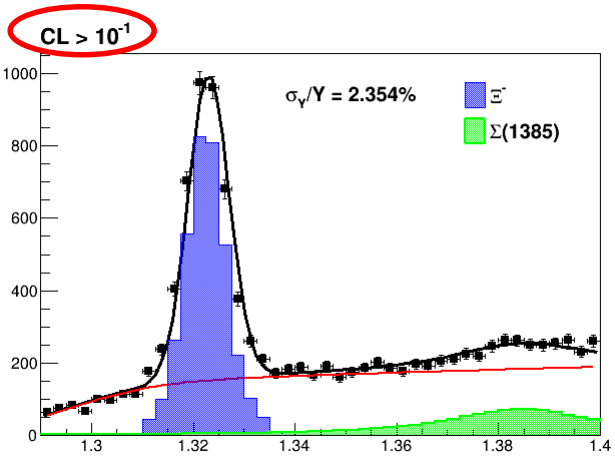
No vertex cut

- Yield extraction: +/- 3σ of Ξ^- peak

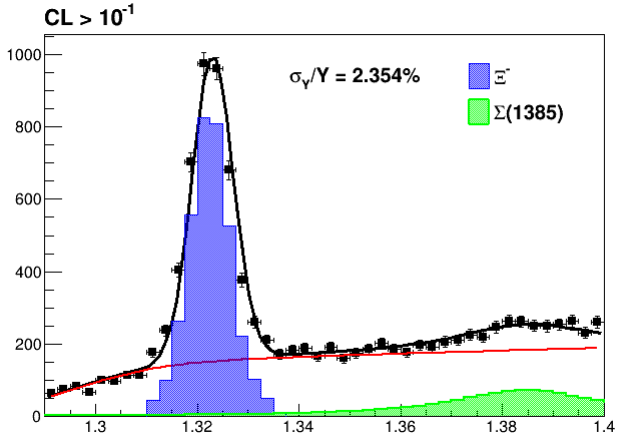


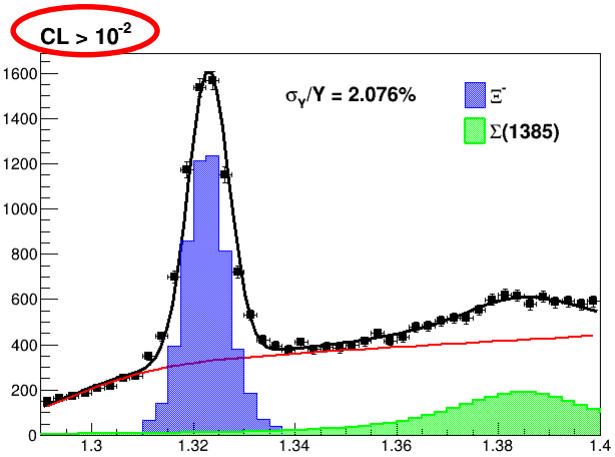
No vertex cut

- Yield extraction: +/- 3σ of Ξ^- peak

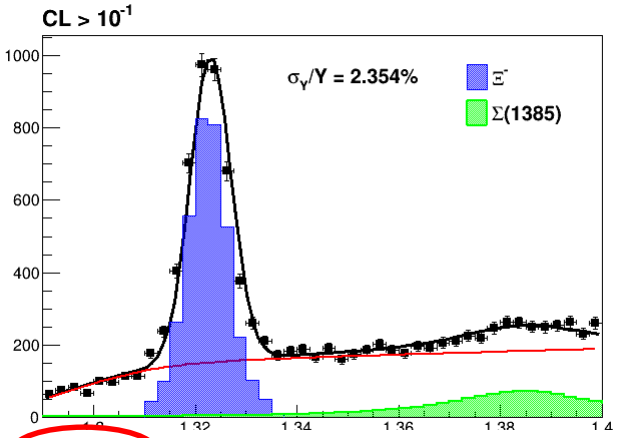


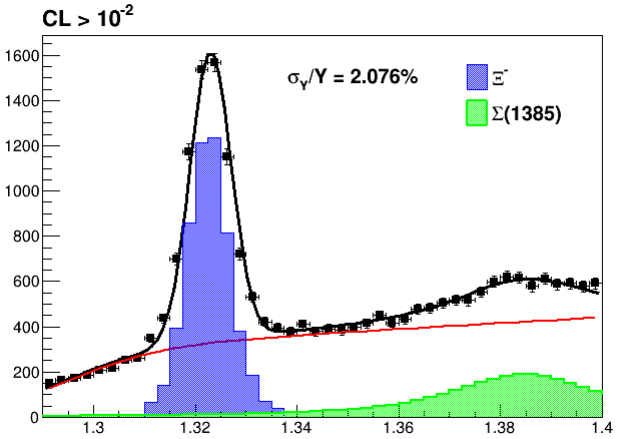
No vertex cut

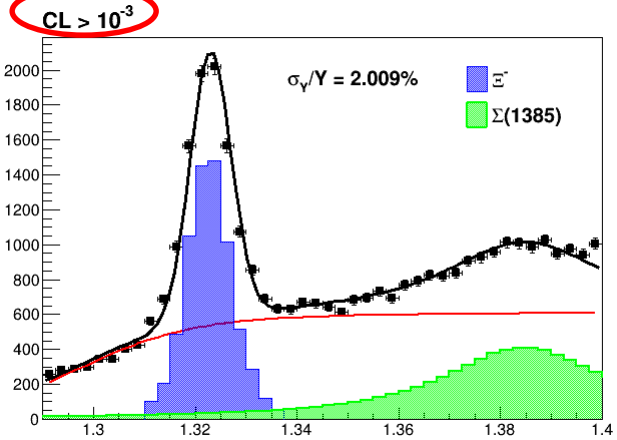




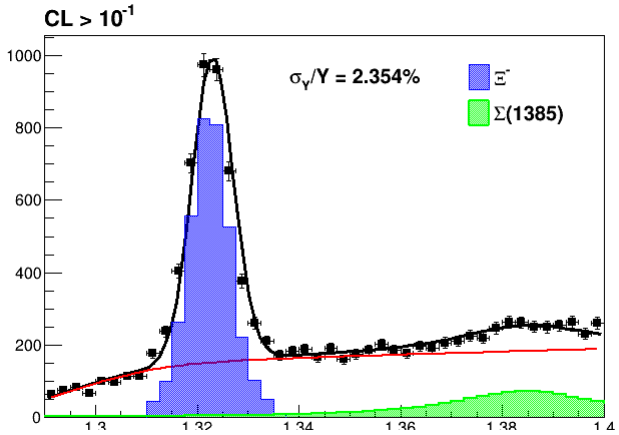
No vertex cut

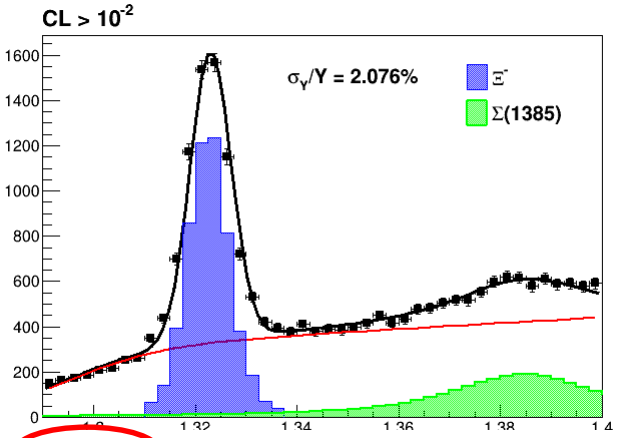


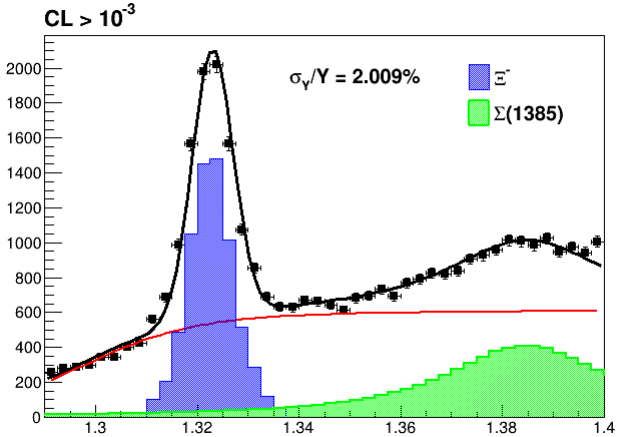


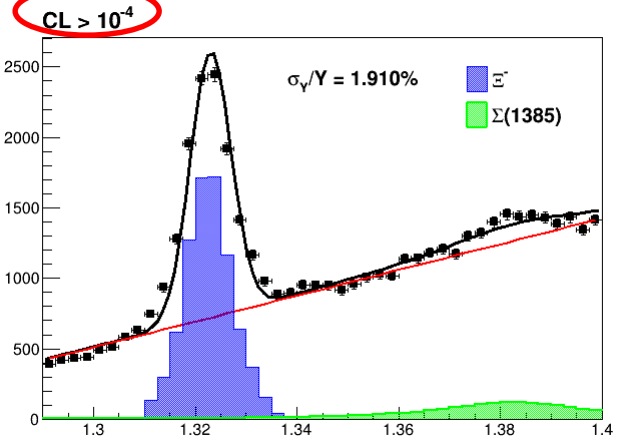


No vertex cut

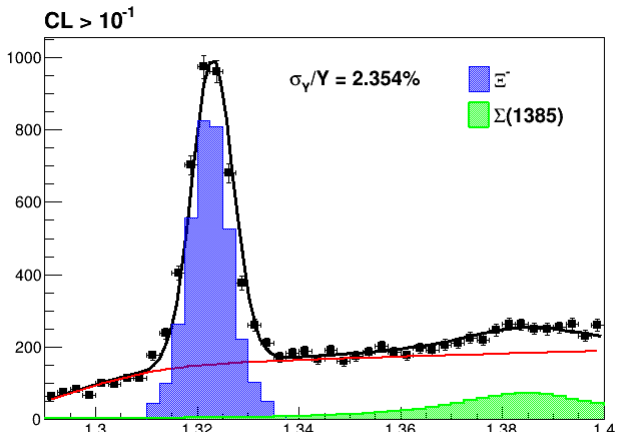


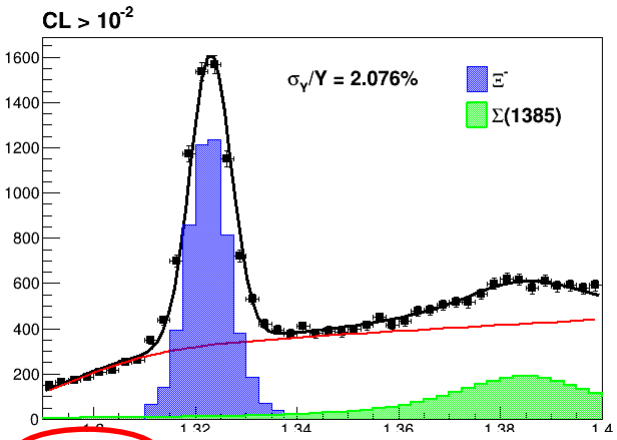


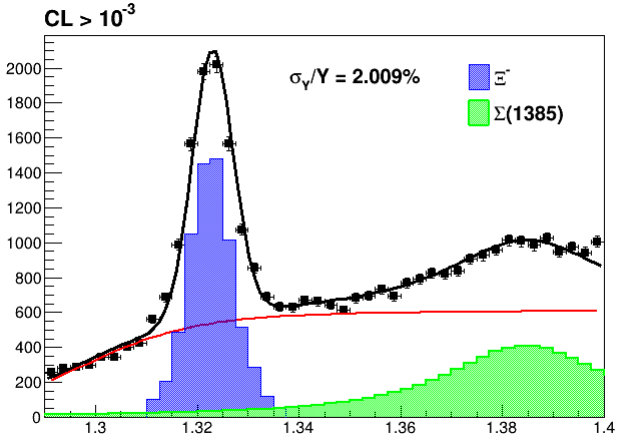


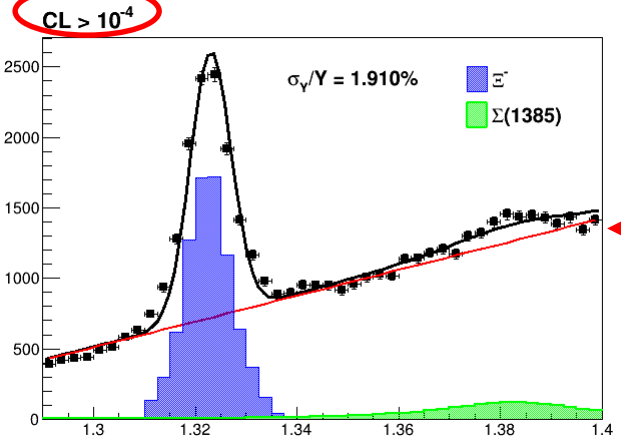


No vertex cut



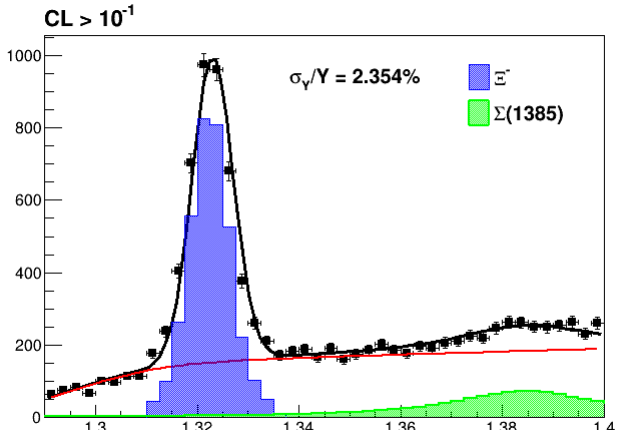


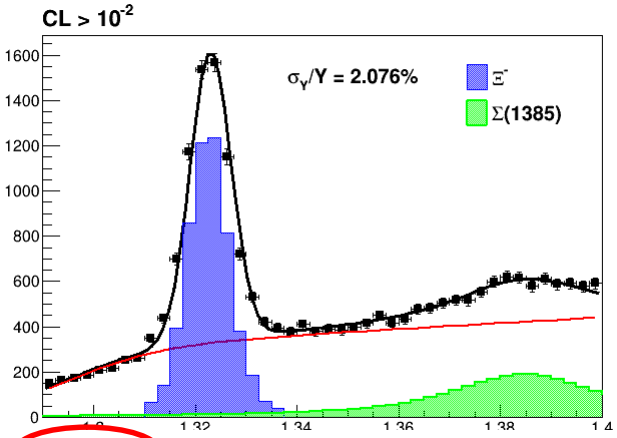


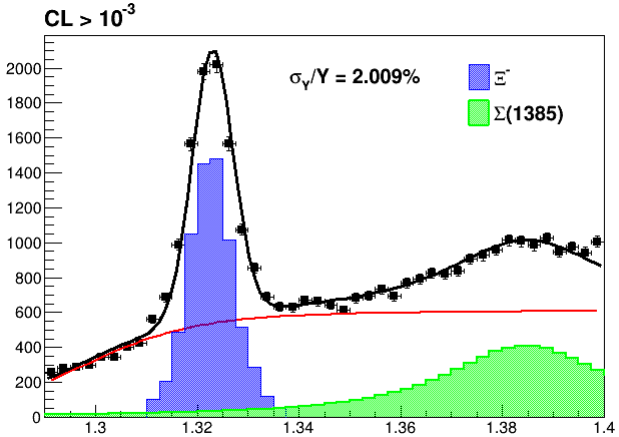


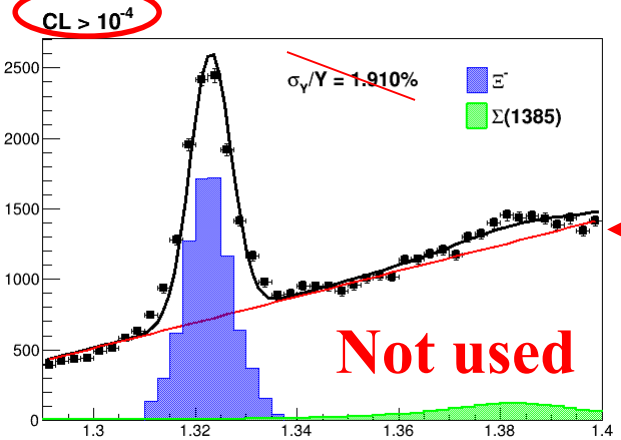
No vertex cut

Fit does not look like the others



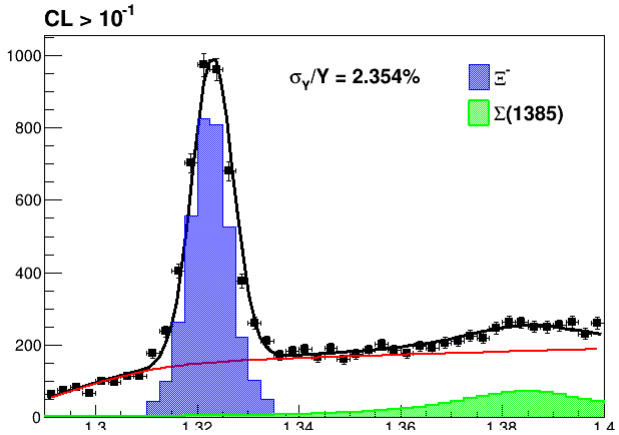


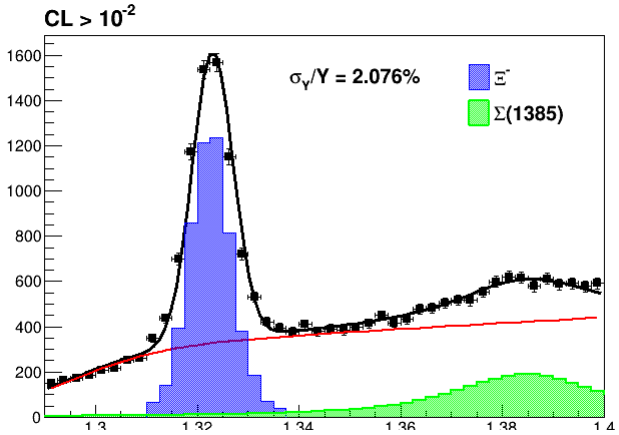


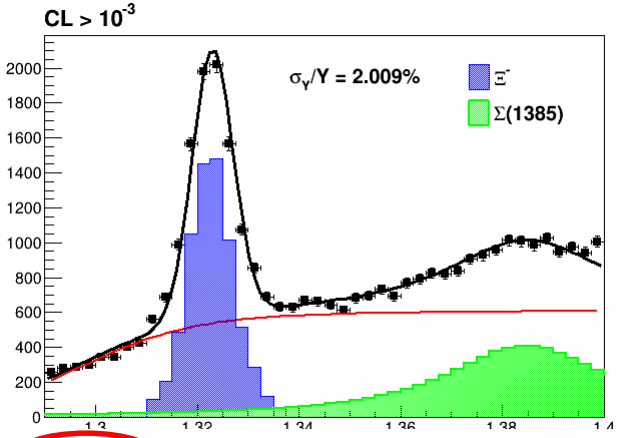


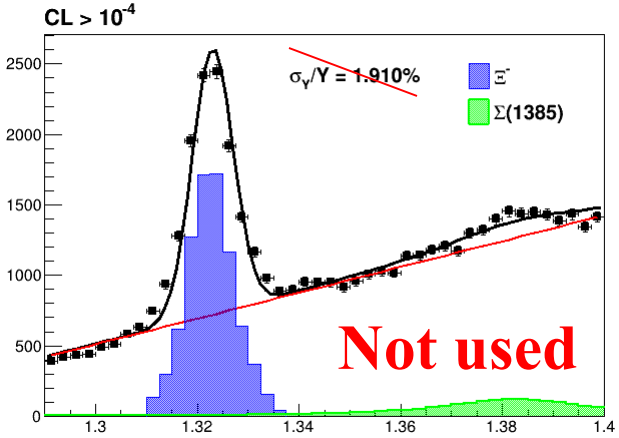
No vertex cut

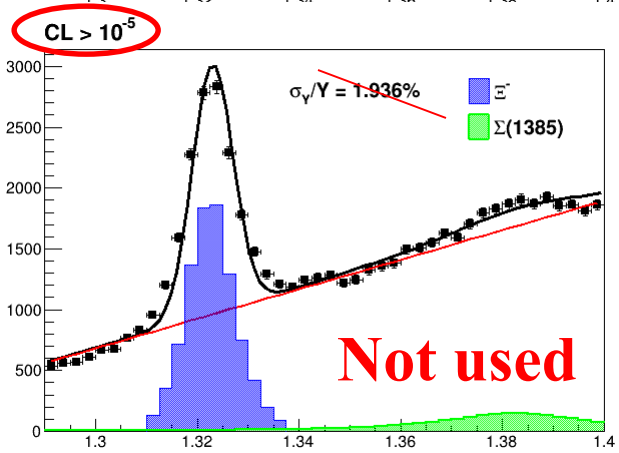
Fit does not look like the others



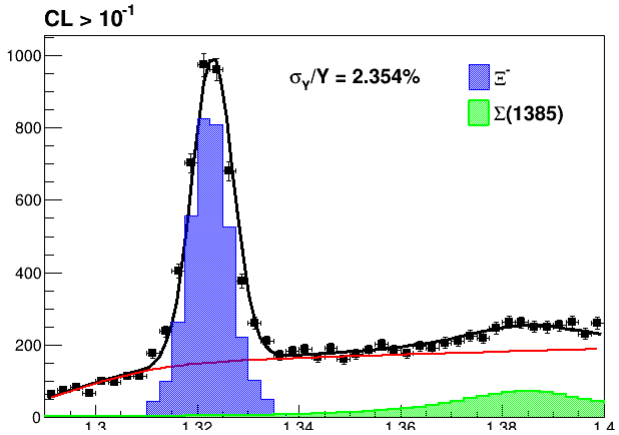


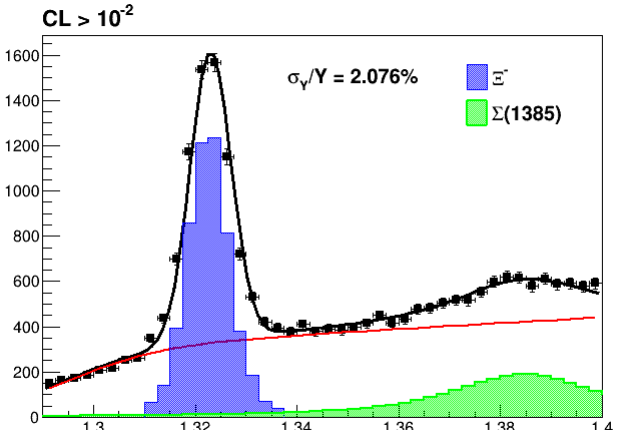


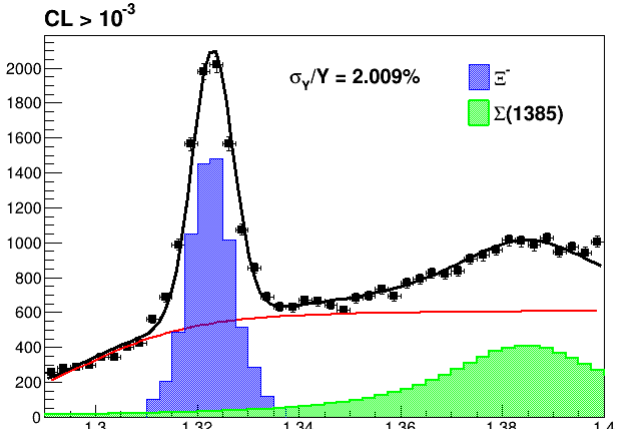


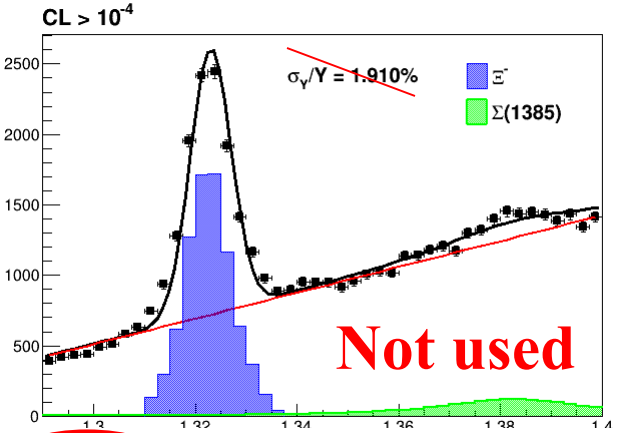


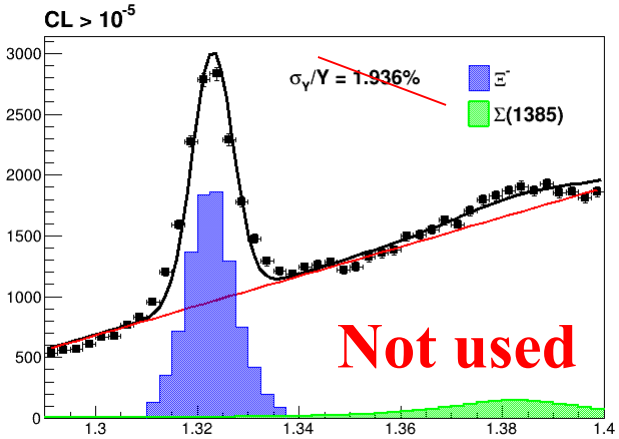
No vertex cut

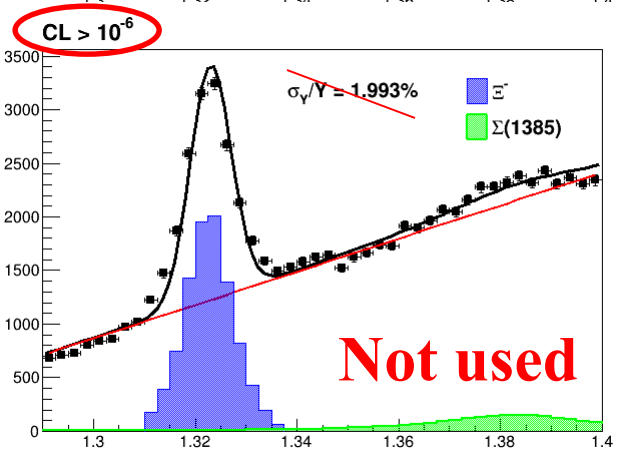




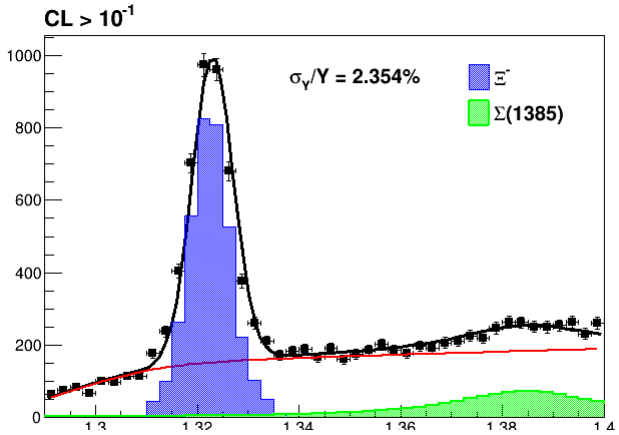


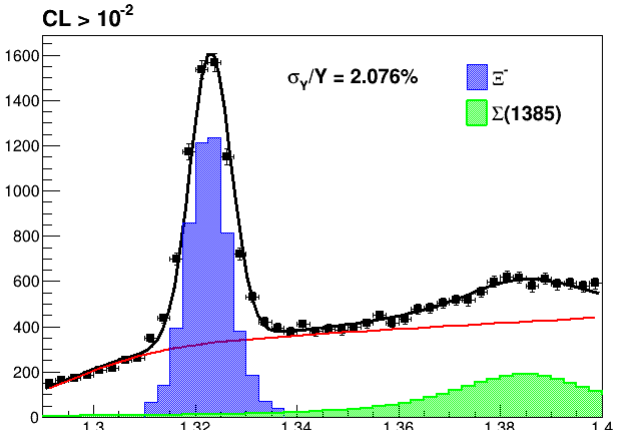


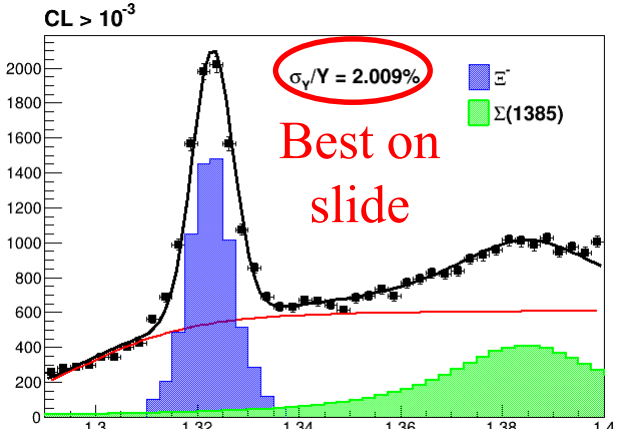


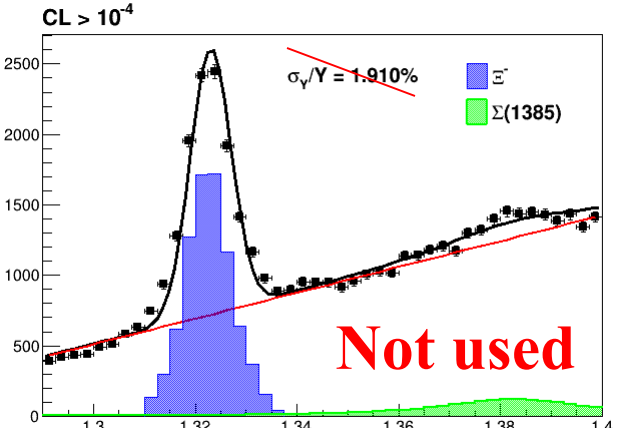


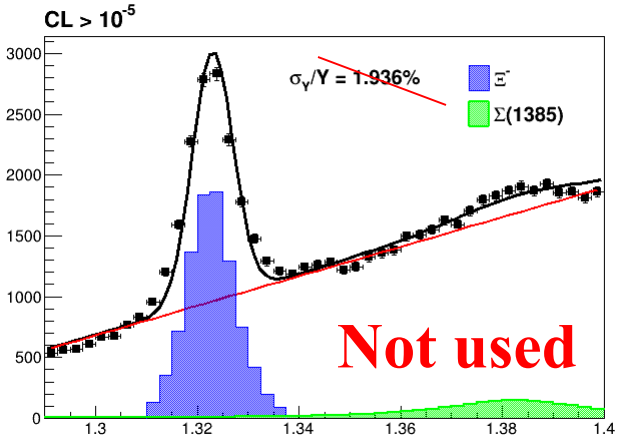
No vertex cut

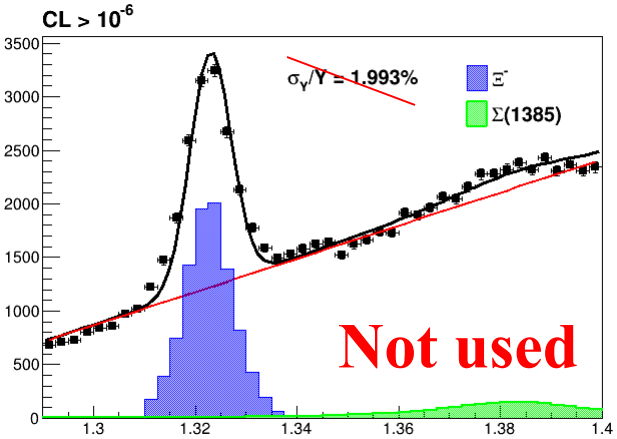




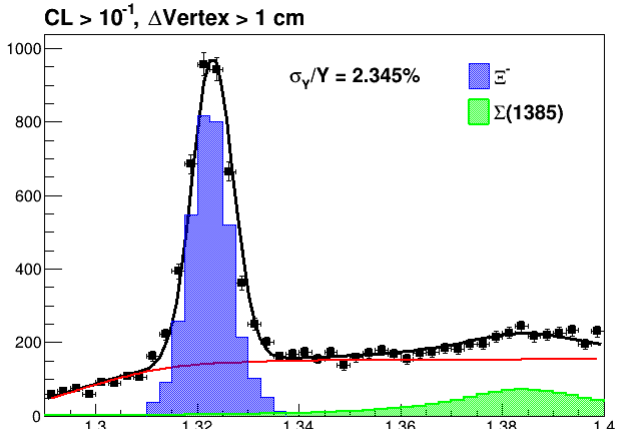


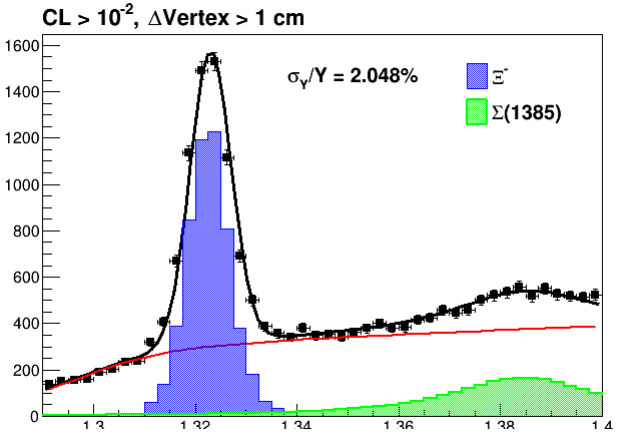




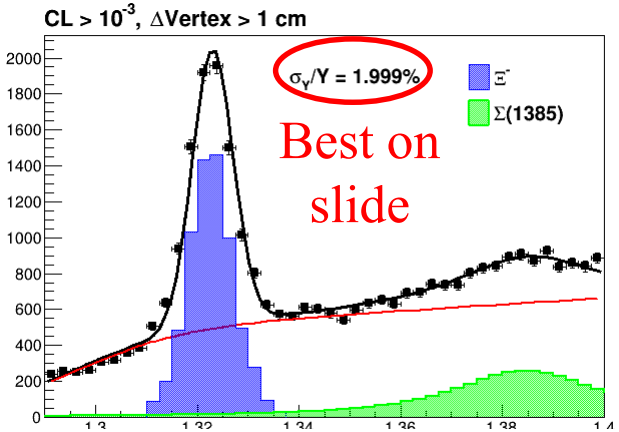


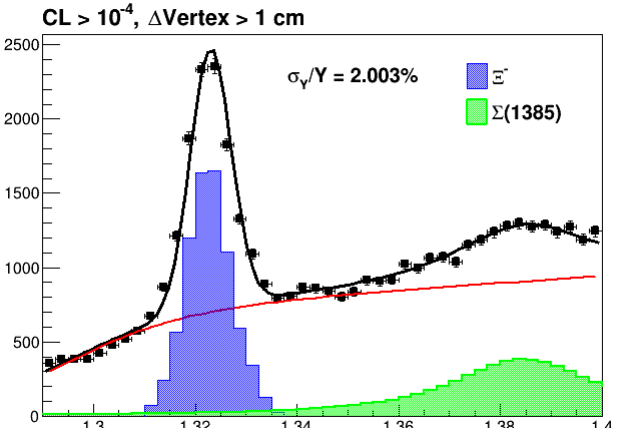
No vertex cut

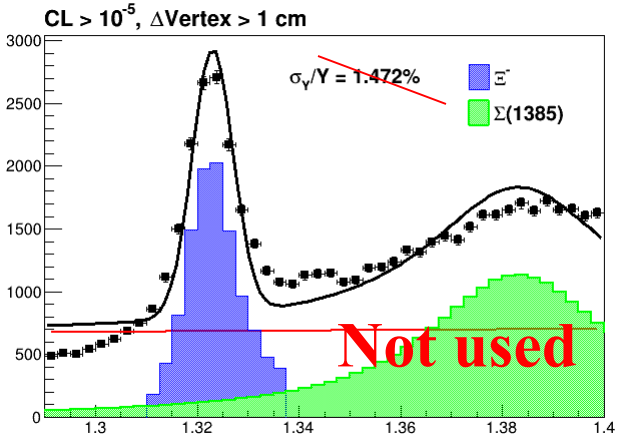

CL > 10^-1, ΔVertex > 1 cm
σY/Y = 2.345%
Ξ-
Σ(1385)

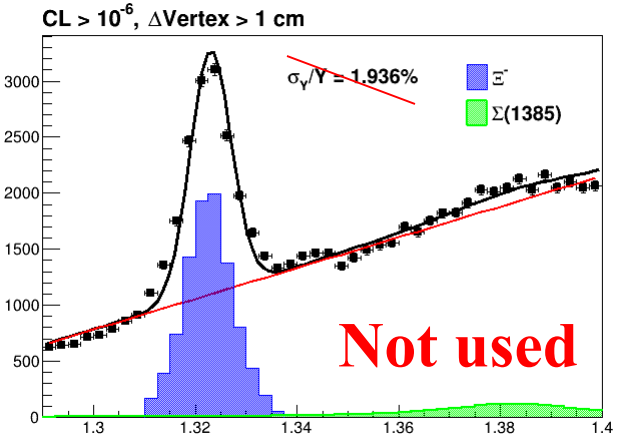

CL > 10^-2, ΔVertex > 1 cm
σY/Y = 2.048%
Ξ-
Σ(1385)

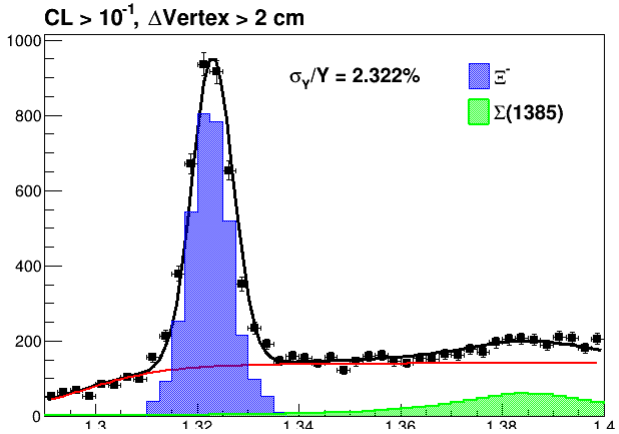
Δvertex > 1 cm

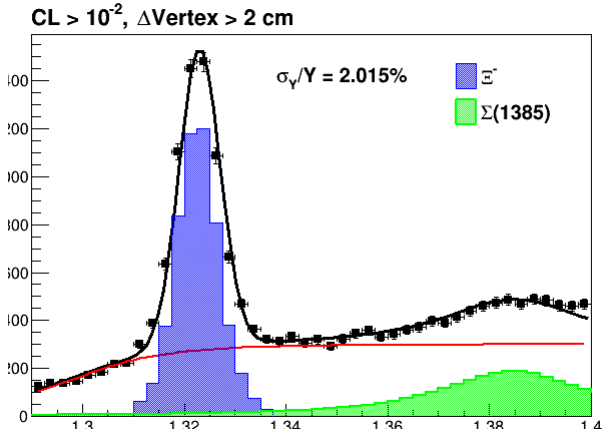

CL > 10^-3, ΔVertex > 1 cm
σY/Y = 1.999%
Ξ-
Σ(1385)
Best on slide


CL > 10^-4, ΔVertex > 1 cm
σY/Y = 2.003%
Ξ-
Σ(1385)

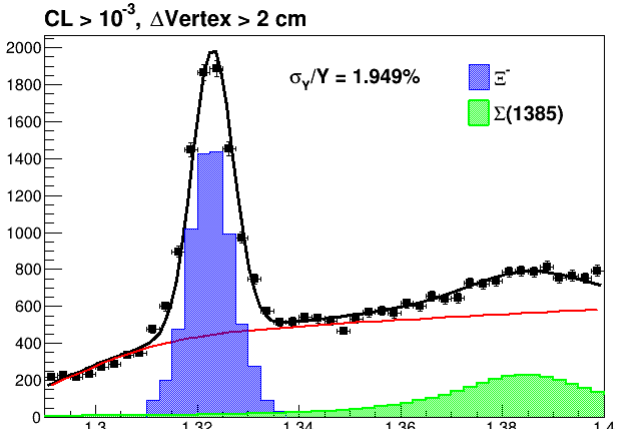

CL > 10^-5, ΔVertex > 1 cm
σY/Y = 1.472%
Ξ-
Σ(1385)
Not used

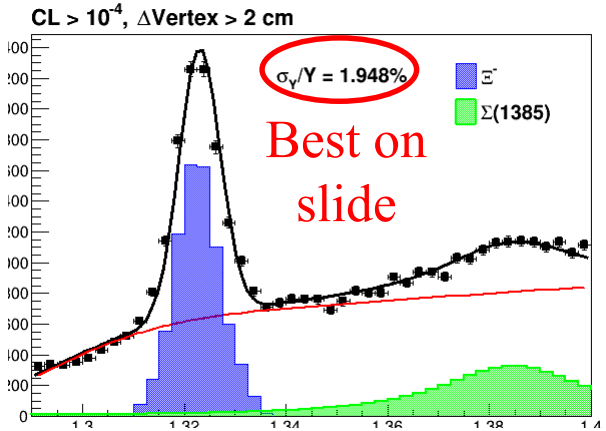

CL > 10^-6, ΔVertex > 1 cm
σY/Y = 1.936%
Ξ-
Σ(1385)
Not used

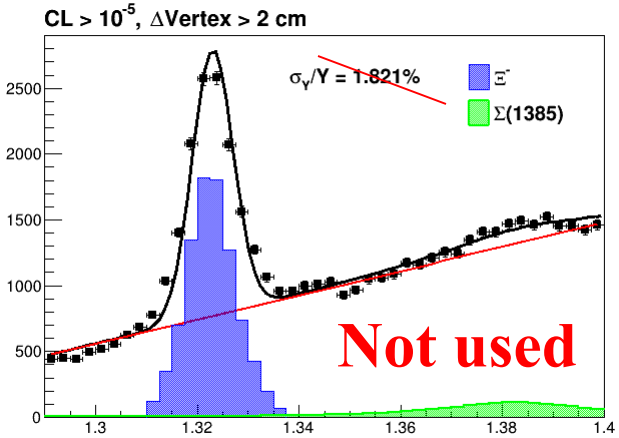

CL > 10^-1, ΔVertex > 2 cm
σ_Y/Y = 2.322%
Ξ⁻
Σ(1385)

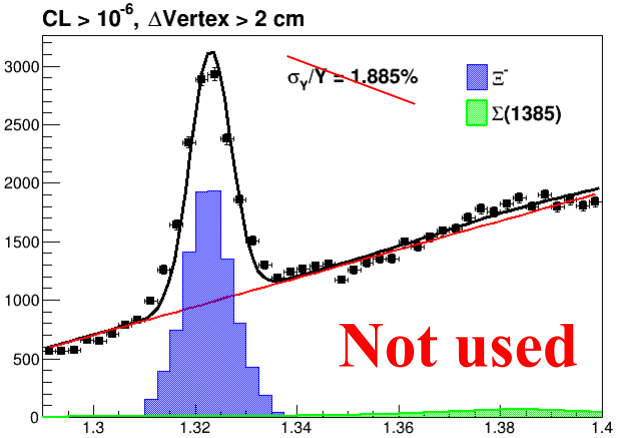

CL > 10^-2, ΔVertex > 2 cm
σ_Y/Y = 2.015%
Ξ⁻
Σ(1385)

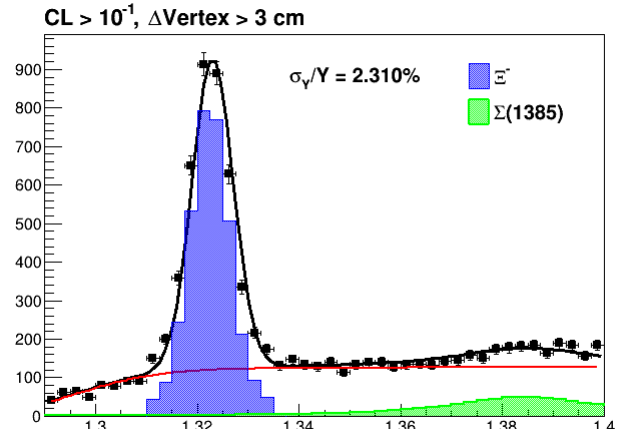
Δvertex > 2 cm

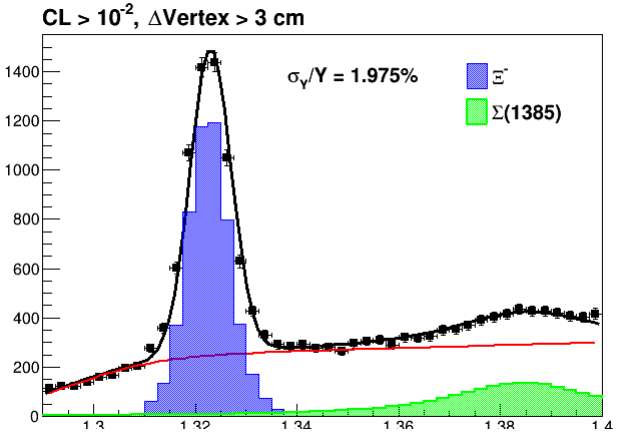

CL > 10^-3, ΔVertex > 2 cm
σ_Y/Y = 1.949%
Ξ⁻
Σ(1385)


CL > 10^-4, ΔVertex > 2 cm
σ_Y/Y = 1.948%
Ξ⁻
Σ(1385)
Best on slide

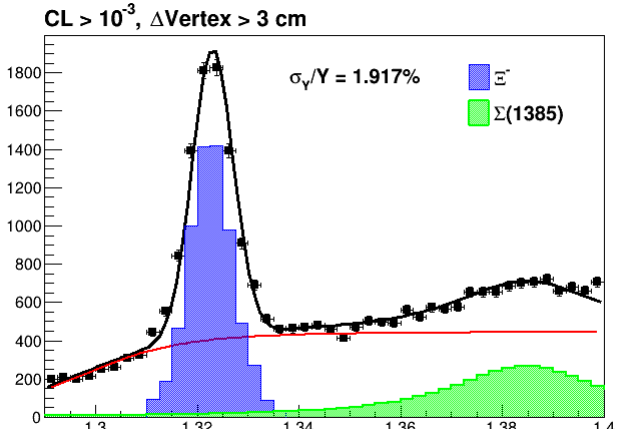

CL > 10^-5, ΔVertex > 2 cm
σ_Y/Y = 1.821%
Ξ⁻
Σ(1385)
Not used

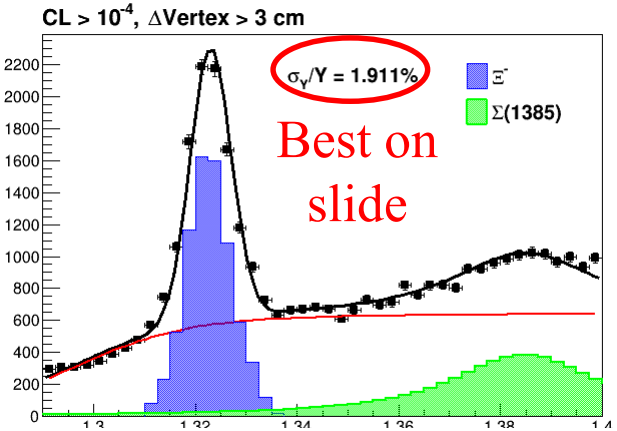

CL > 10^-6, ΔVertex > 2 cm
σ_Y/Y = 1.885%
Ξ⁻
Σ(1385)
Not used

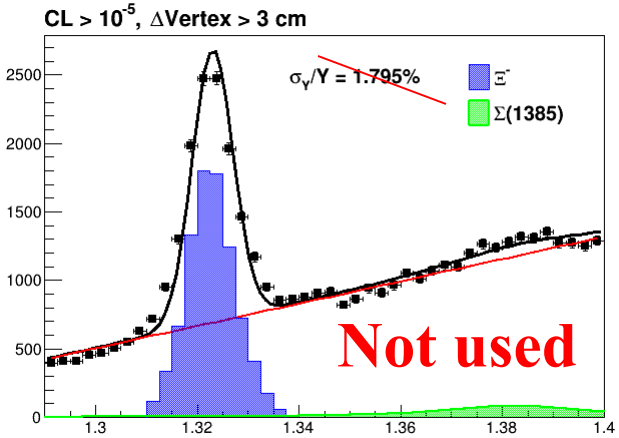

CL > 10^-1, ΔVertex > 3 cm
σY/Y = 2.310%
Ξ-
Σ(1385)

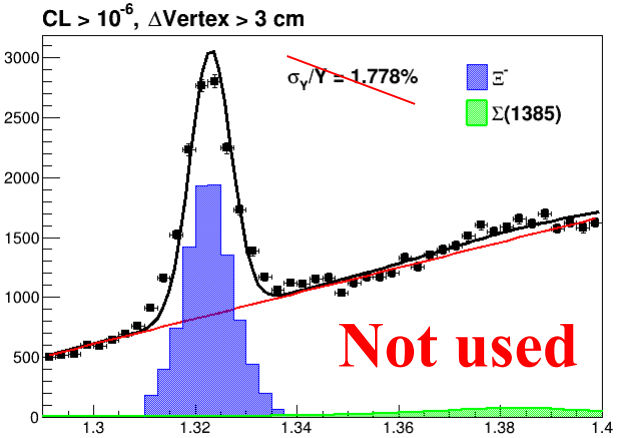

CL > 10^-2, ΔVertex > 3 cm
σY/Y = 1.975%
Ξ-
Σ(1385)

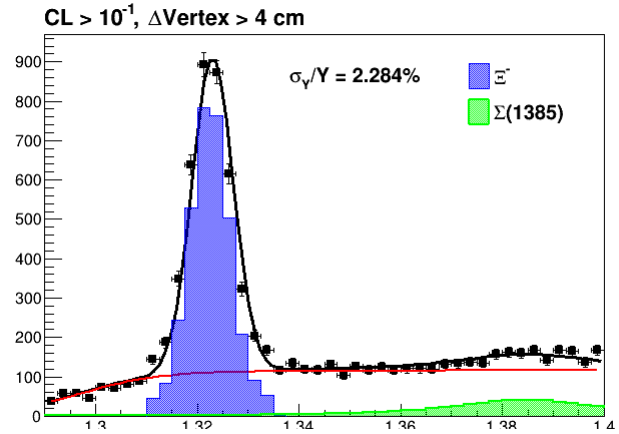
Δvertex > 3 cm

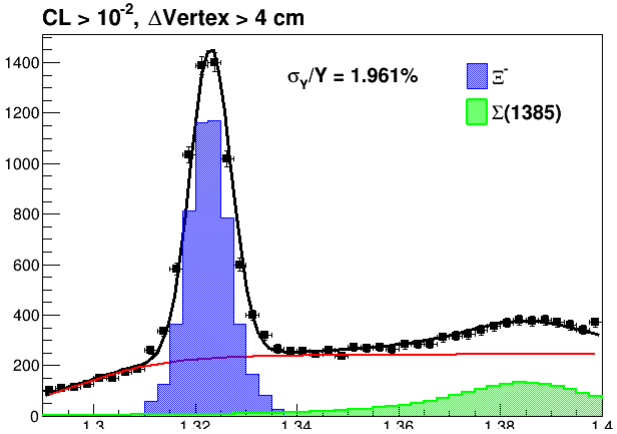

CL > 10^-3, ΔVertex > 3 cm
σY/Y = 1.917%
Ξ-
Σ(1385)


CL > 10^-4, ΔVertex > 3 cm
σY/Y = 1.911%
Ξ-
Σ(1385)
Best on slide

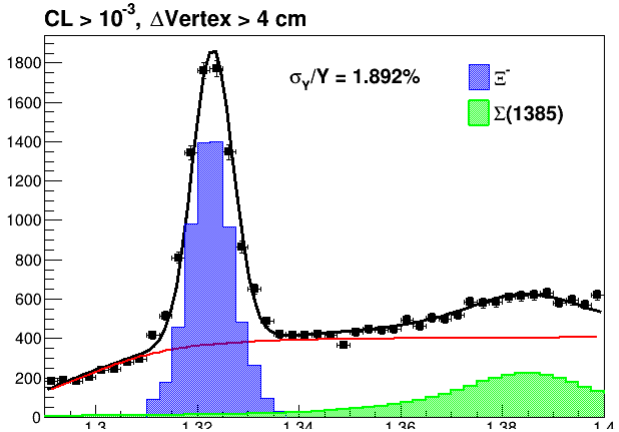

CL > 10^-5, ΔVertex > 3 cm
σY/Y = 1.795%
Ξ-
Σ(1385)
Not used

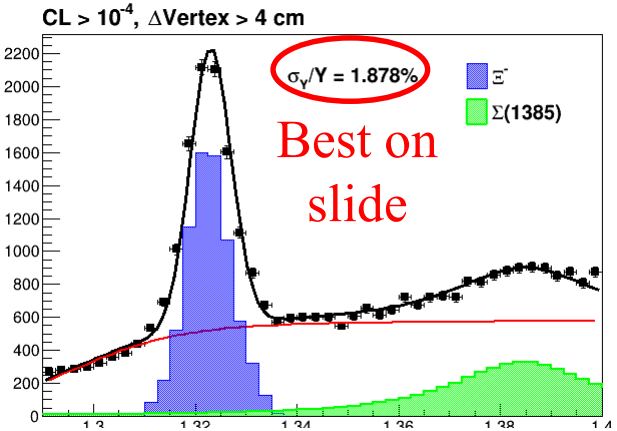

CL > 10^-6, ΔVertex > 3 cm
σY/Y = 1.778%
Ξ-
Σ(1385)
Not used

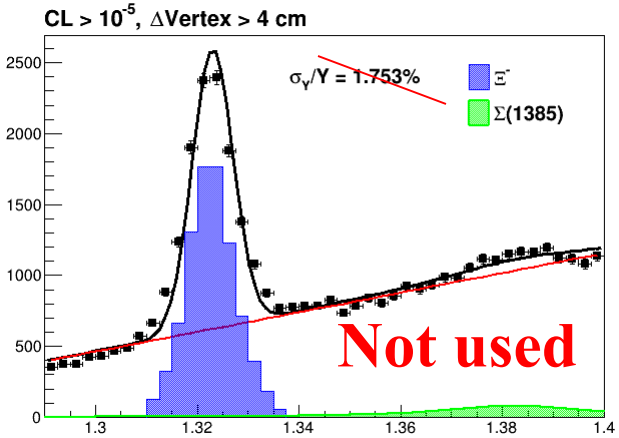

CL > 10^-1, ΔVertex > 4 cm
σY/Y = 2.284%
Ξ-
Σ(1385)

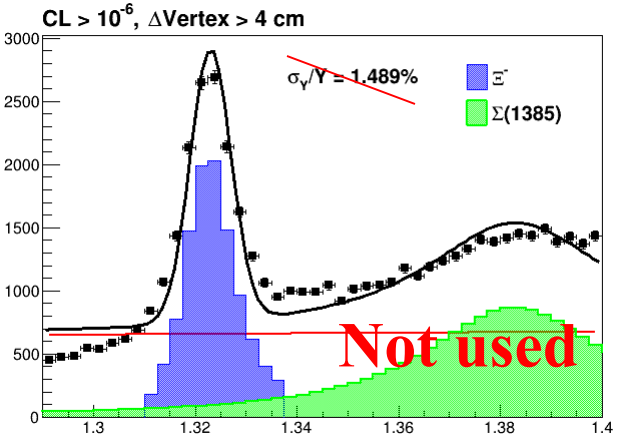

CL > 10^-2, ΔVertex > 4 cm
σY/Y = 1.961%
Ξ-
Σ(1385)

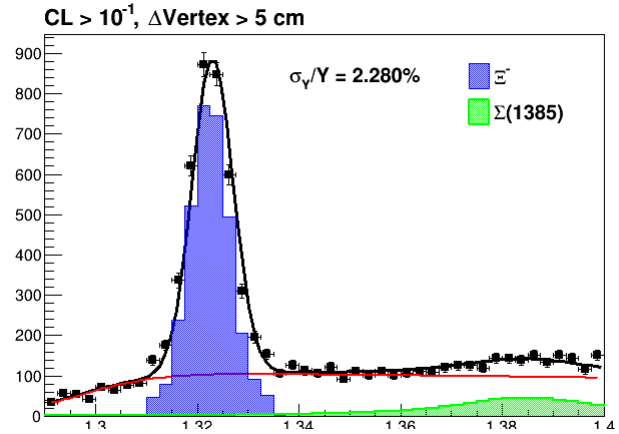
Δvertex > 4 cm

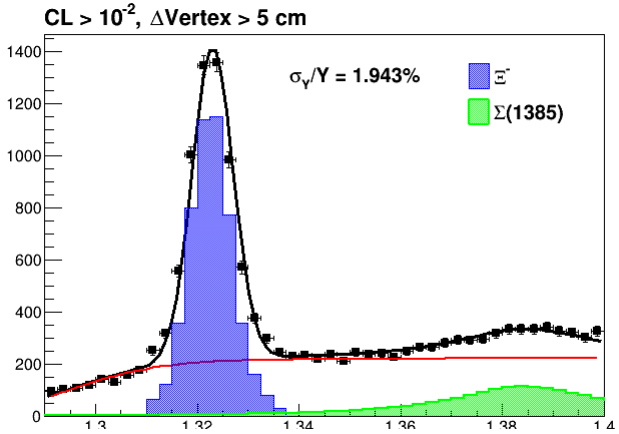

CL > 10^-3, ΔVertex > 4 cm
σY/Y = 1.892%
Ξ-
Σ(1385)


CL > 10^-4, ΔVertex > 4 cm
σY/Y = 1.878%
Ξ-
Σ(1385)
Best on slide

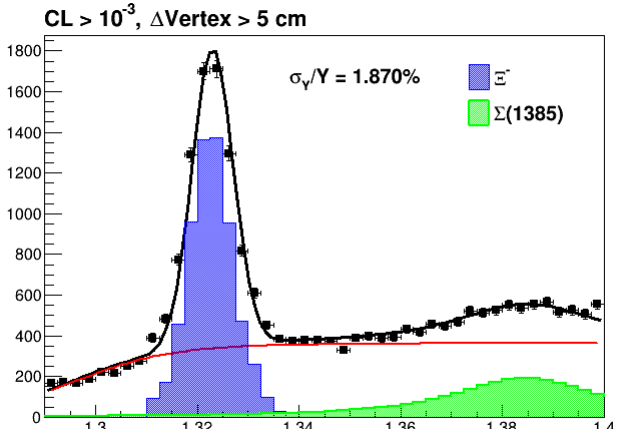

CL > 10^-5, ΔVertex > 4 cm
σY/Y = 1.753%
Ξ-
Σ(1385)
Not used

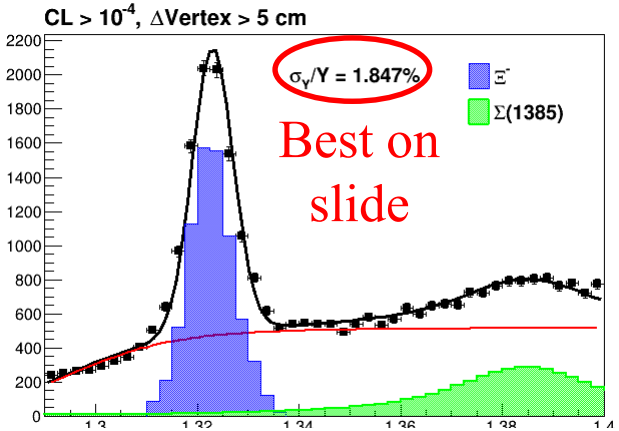

CL > 10^-6, ΔVertex > 4 cm
σY/Y = 1.489%
Ξ-
Σ(1385)
Not used

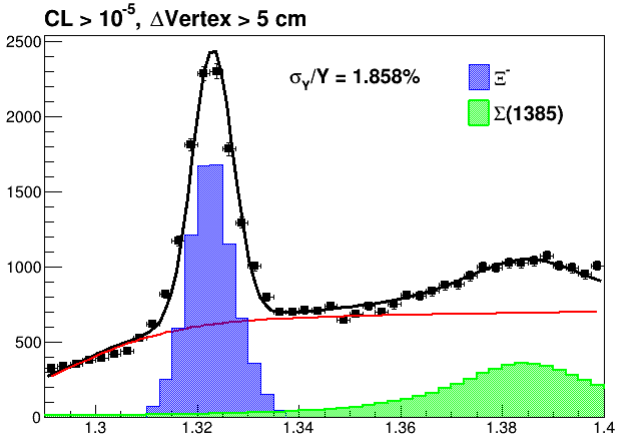

CL > 10^-1, ΔVertex > 5 cm
σ_Y/Y = 2.280%
Ξ⁻
Σ(1385)

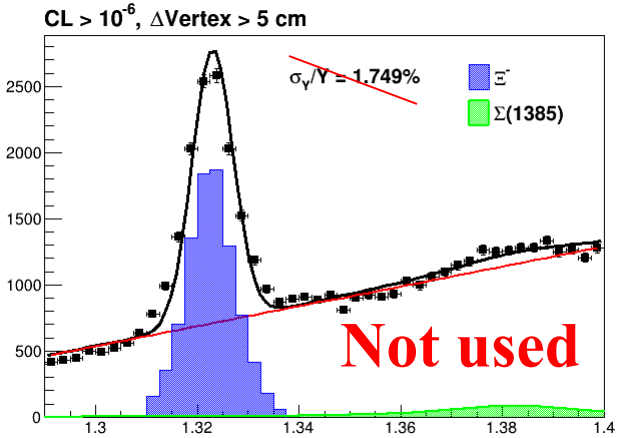

CL > 10^-2, ΔVertex > 5 cm
σ_Y/Y = 1.943%
Ξ⁻
Σ(1385)

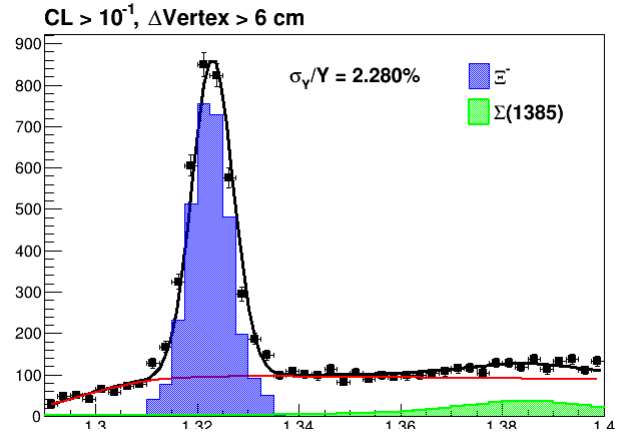
Δvertex > 5 cm

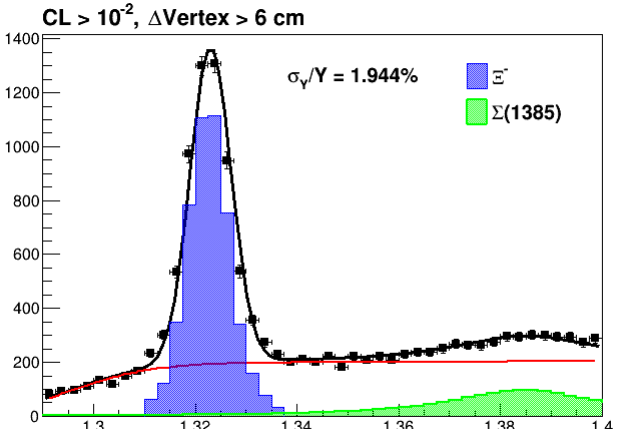

CL > 10^-3, ΔVertex > 5 cm
σ_Y/Y = 1.870%
Ξ⁻
Σ(1385)


CL > 10^-4, ΔVertex > 5 cm
σ_Y/Y = 1.847%
Ξ⁻
Σ(1385)
Best on slide

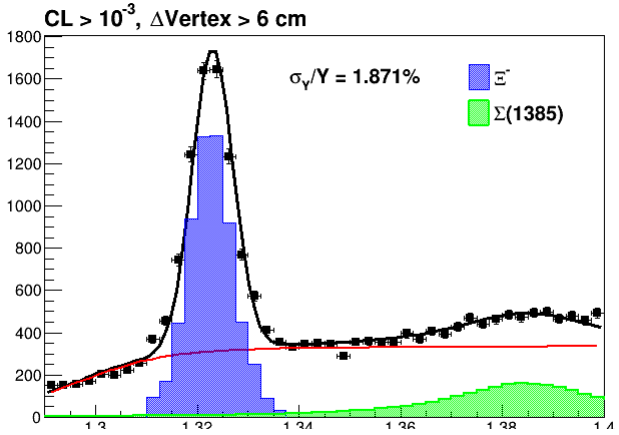

CL > 10^-5, ΔVertex > 5 cm
σ_Y/Y = 1.858%
Ξ⁻
Σ(1385)

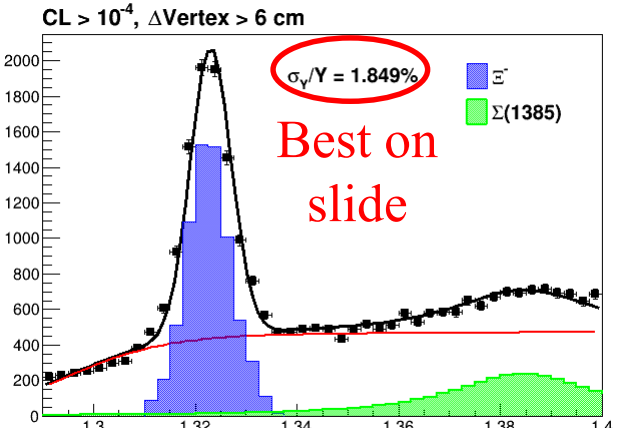

CL > 10^-6, ΔVertex > 5 cm
σ_Y/Y = 1.749%
Ξ⁻
Σ(1385)
Not used

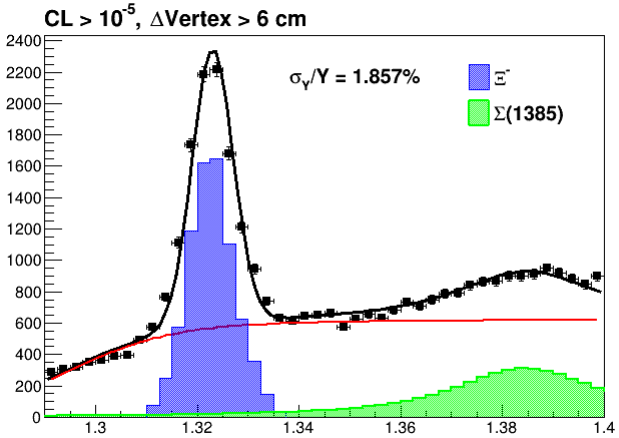

CL > 10^-1, ΔVertex > 6 cm
σ_Y/Y = 2.280%
Ξ⁻
Σ(1385)

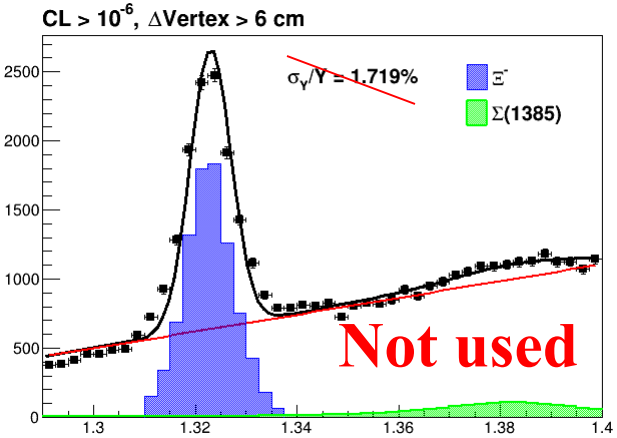

CL > 10^-2, ΔVertex > 6 cm
σ_Y/Y = 1.944%
Ξ⁻
Σ(1385)

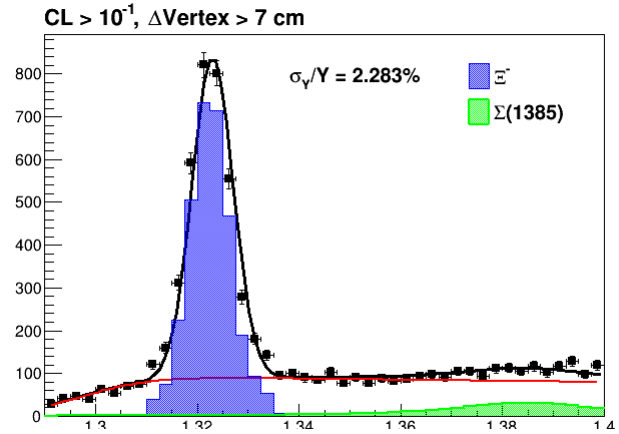
Δvertex > 6 cm

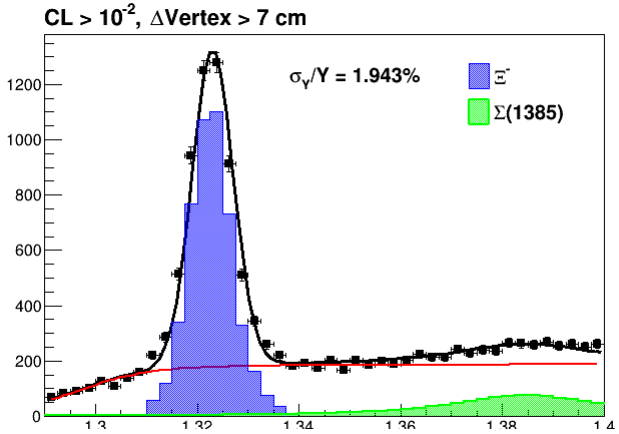

CL > 10^-3, ΔVertex > 6 cm
σ_Y/Y = 1.871%
Ξ⁻
Σ(1385)


CL > 10^-4, ΔVertex > 6 cm
σ_Y/Y = 1.849%
Ξ⁻
Σ(1385)
Best on slide

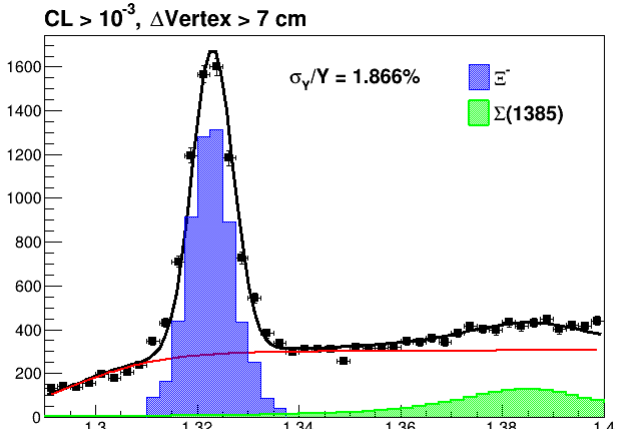

CL > 10^-5, ΔVertex > 6 cm
σ_Y/Y = 1.857%
Ξ⁻
Σ(1385)

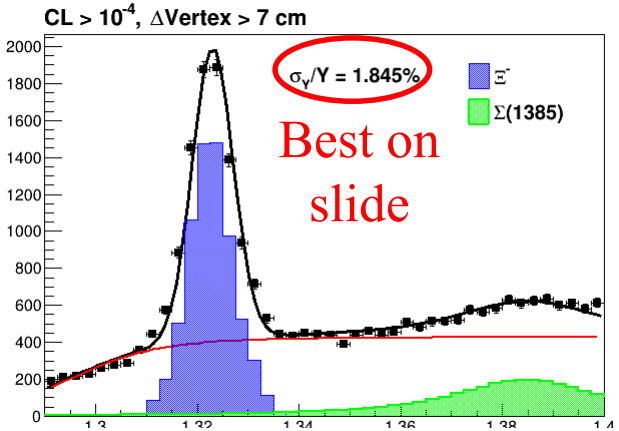

CL > 10^-6, ΔVertex > 6 cm
σ_Y/Y = 1.719%
Ξ⁻
Σ(1385)
Not used

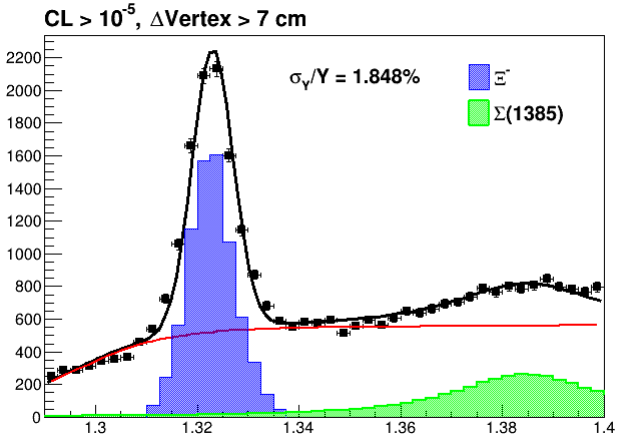

CL > 10^-1, ΔVertex > 7 cm
σ_Y/Y = 2.283%
Ξ⁻
Σ(1385)

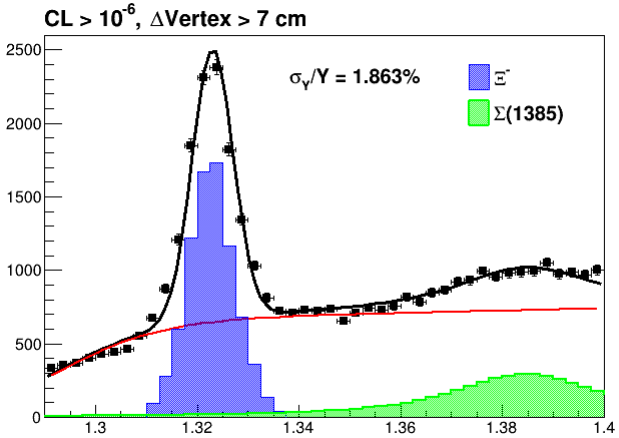

CL > 10^-2, ΔVertex > 7 cm
σ_Y/Y = 1.943%
Ξ⁻
Σ(1385)

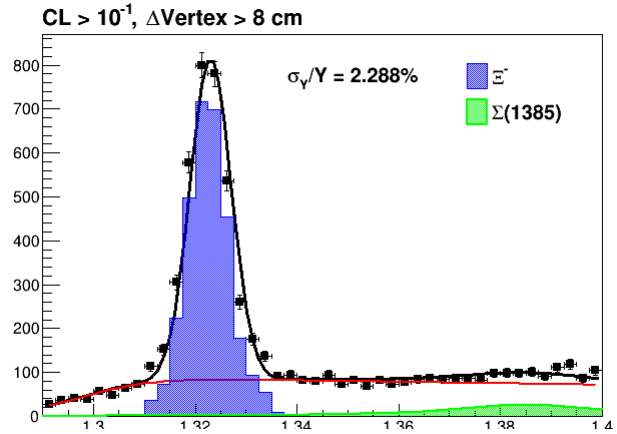
Δvertex > 7 cm

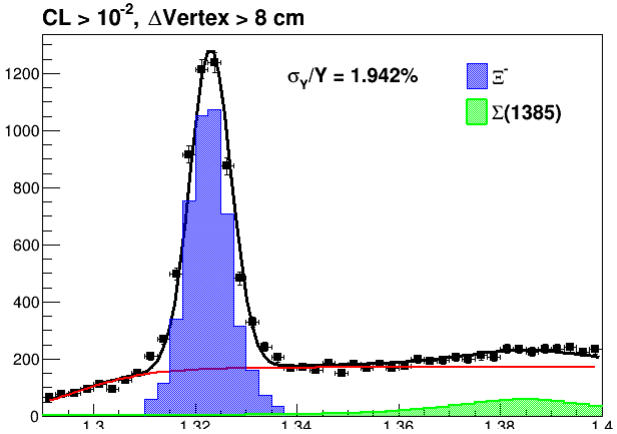

CL > 10^-3, ΔVertex > 7 cm
σ_Y/Y = 1.866%
Ξ⁻
Σ(1385)


CL > 10^-4, ΔVertex > 7 cm
σ_Y/Y = 1.845%
Ξ⁻
Σ(1385)
Best on slide

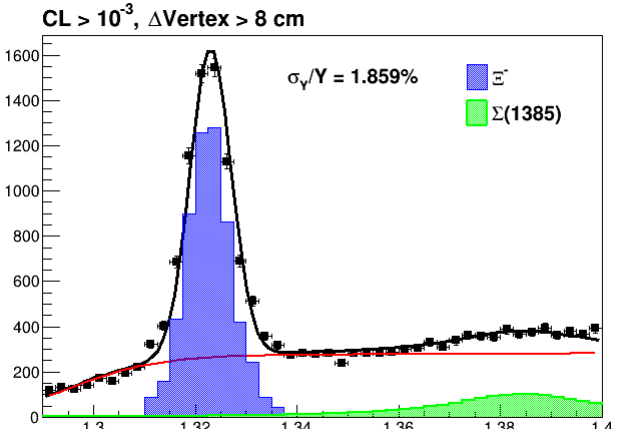

CL > 10^-5, ΔVertex > 7 cm
σ_Y/Y = 1.848%
Ξ⁻
Σ(1385)

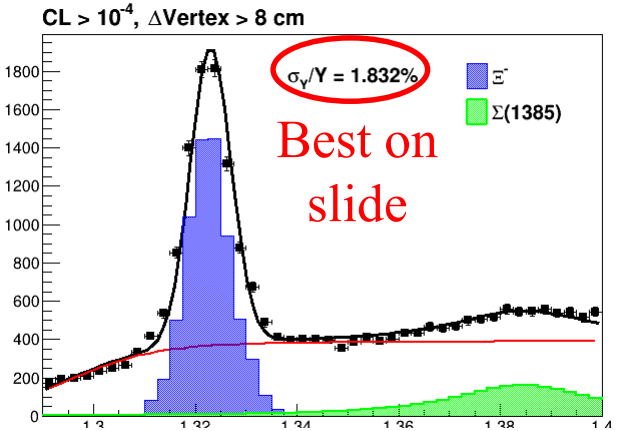

CL > 10^-6, ΔVertex > 7 cm
σ_Y/Y = 1.863%
Ξ⁻
Σ(1385)

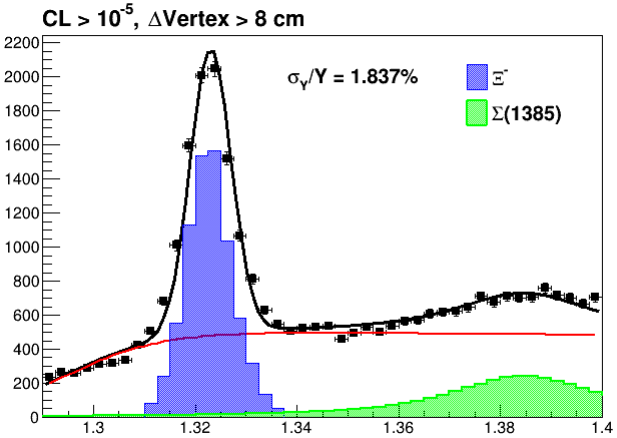

CL > 10^-1, ΔVertex > 8 cm
σY/Y = 2.288%
Ξ-
Σ(1385)

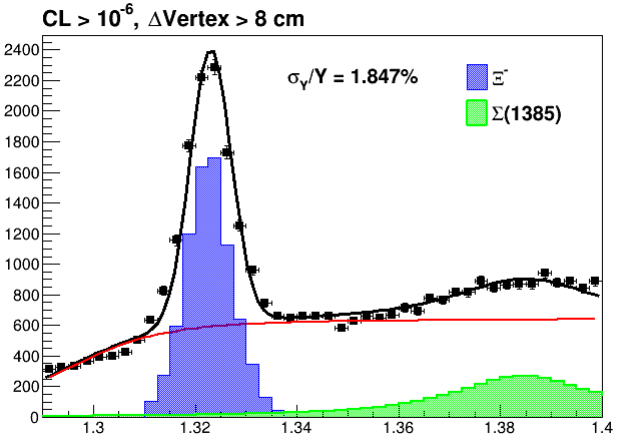

CL > 10^-2, ΔVertex > 8 cm
σY/Y = 1.942%
Ξ-
Σ(1385)

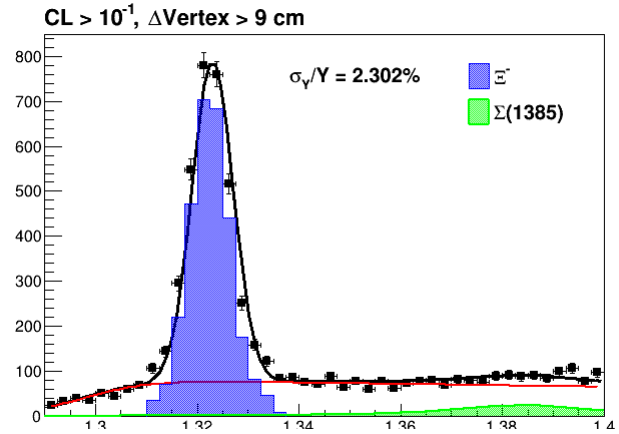
Δvertex > 8 cm

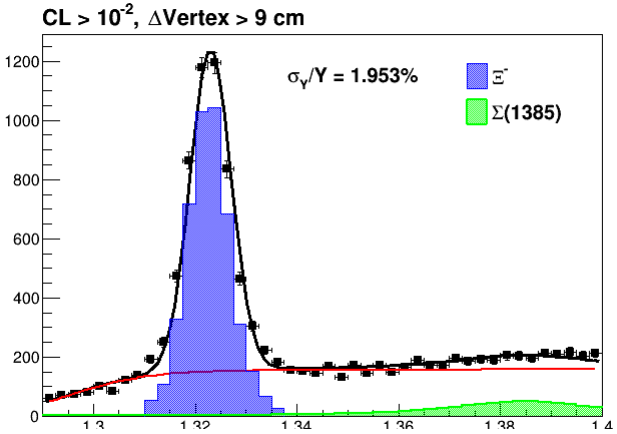

CL > 10^-3, ΔVertex > 8 cm
σY/Y = 1.859%
Ξ-
Σ(1385)


CL > 10^-4, ΔVertex > 8 cm
σY/Y = 1.832%
Ξ-
Σ(1385)
Best on slide

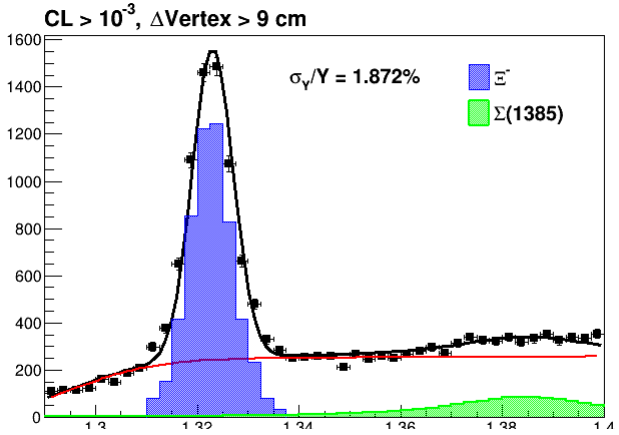

CL > 10^-5, ΔVertex > 8 cm
σY/Y = 1.837%
Ξ-
Σ(1385)

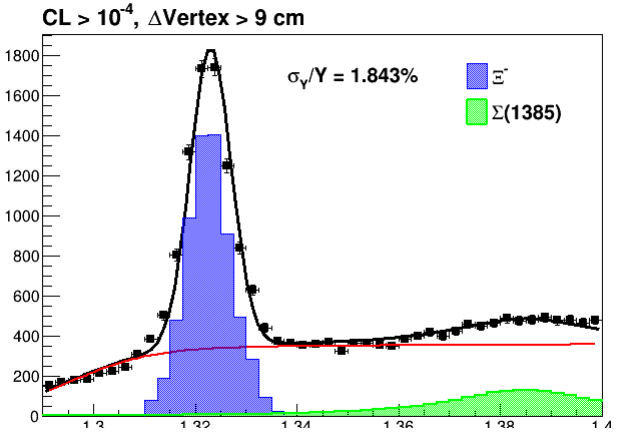

CL > 10^-6, ΔVertex > 8 cm
σY/Y = 1.847%
Ξ-
Σ(1385)

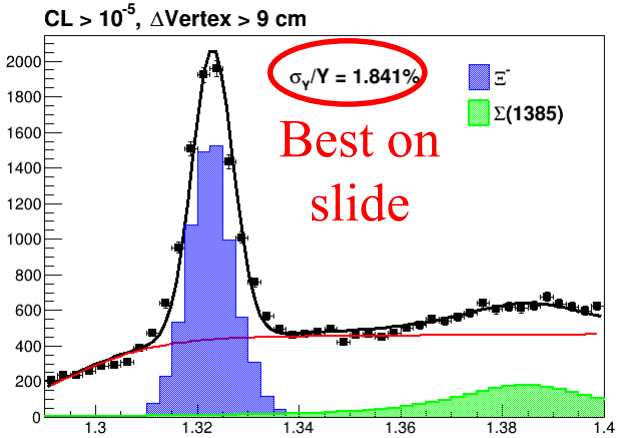

CL > 10^-1, ΔVertex > 9 cm
σY/Y = 2.302%
Ξ-
Σ(1385)

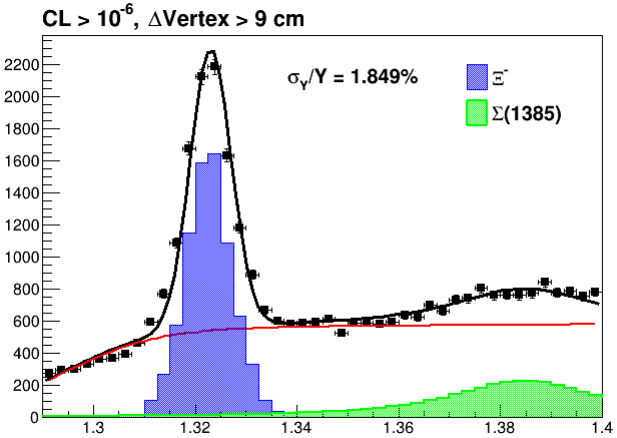

CL > 10^-2, ΔVertex > 9 cm
σY/Y = 1.953%
Ξ-
Σ(1385)

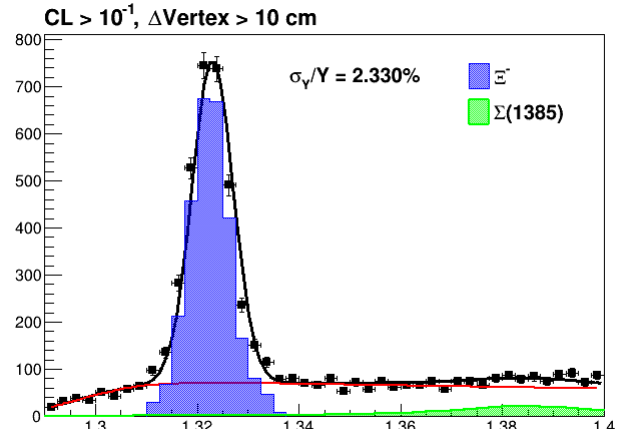
Δvertex > 9 cm

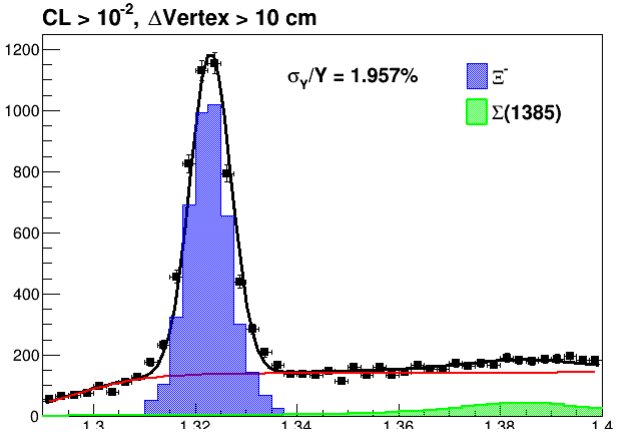

CL > 10^-3, ΔVertex > 9 cm
σY/Y = 1.872%
Ξ-
Σ(1385)


CL > 10^-4, ΔVertex > 9 cm
σY/Y = 1.843%
Ξ-
Σ(1385)

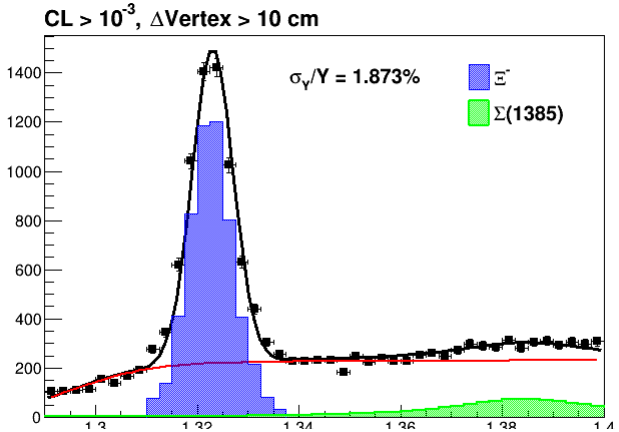

CL > 10^-5, ΔVertex > 9 cm
σY/Y = 1.841%
Ξ-
Σ(1385)
Best on slide

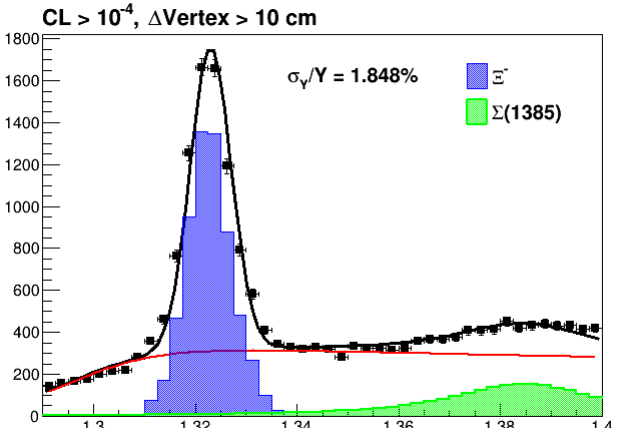

CL > 10^-6, ΔVertex > 9 cm
σY/Y = 1.849%
Ξ-
Σ(1385)

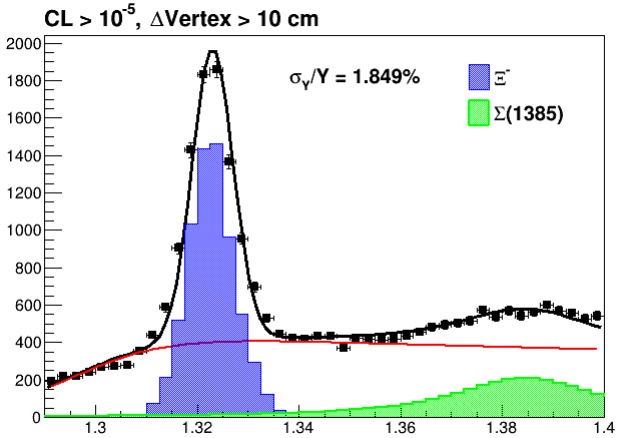


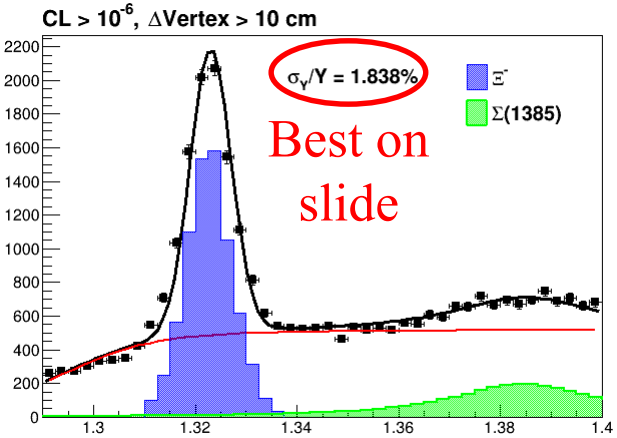


Δvertex > 10 cm

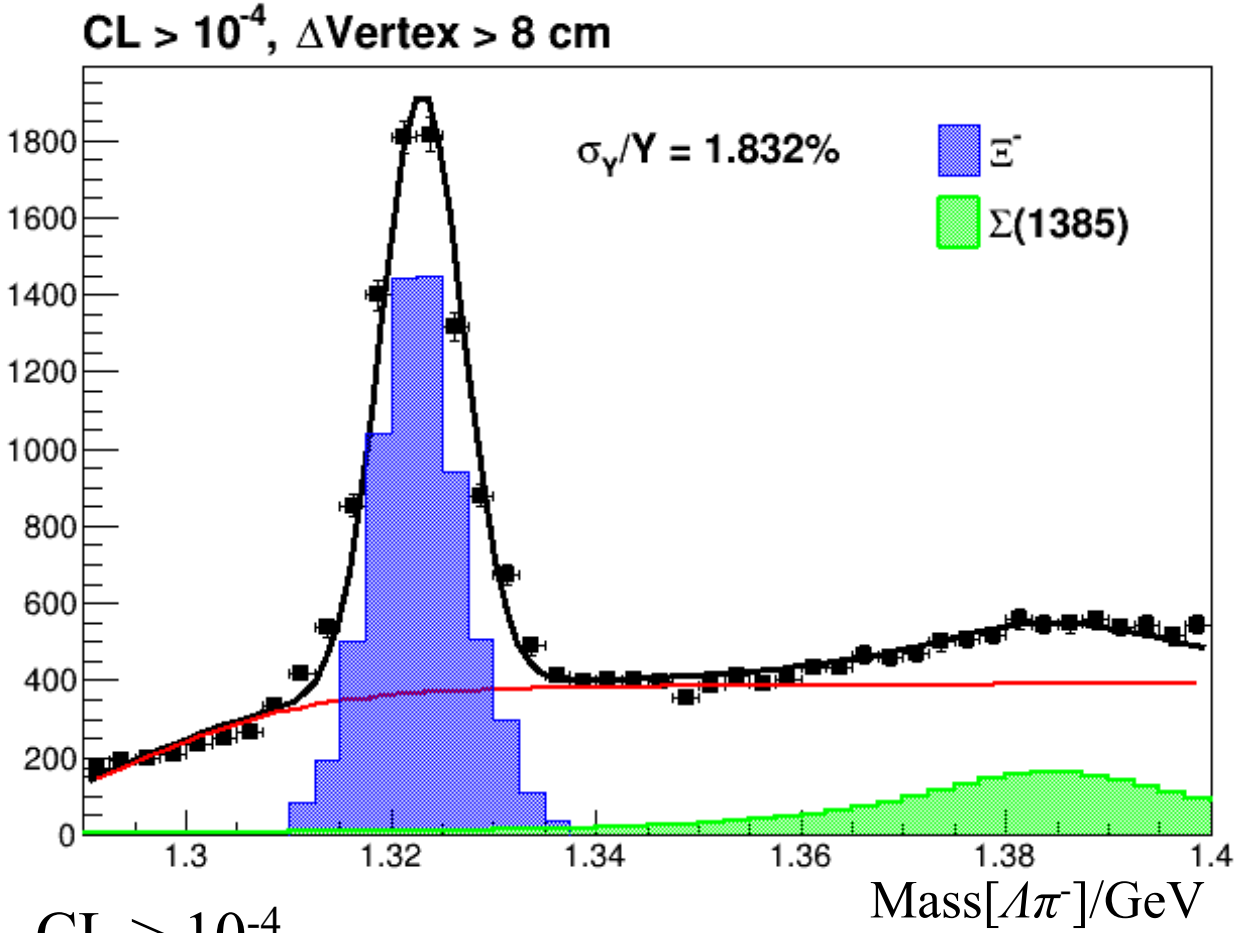






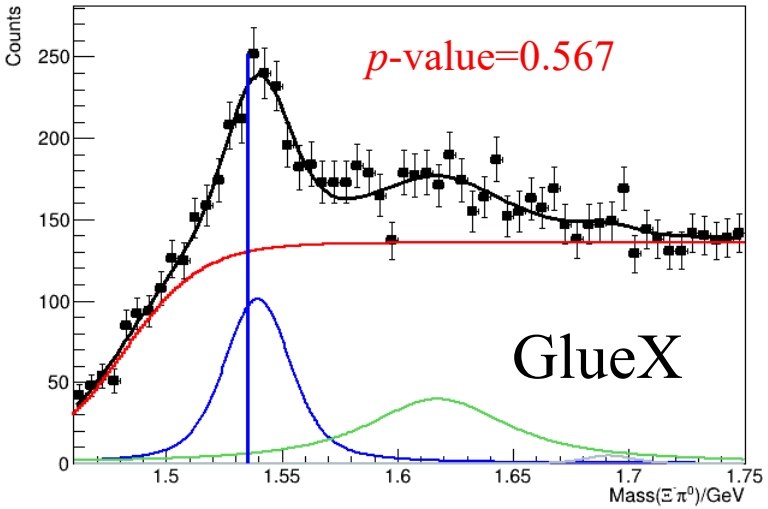


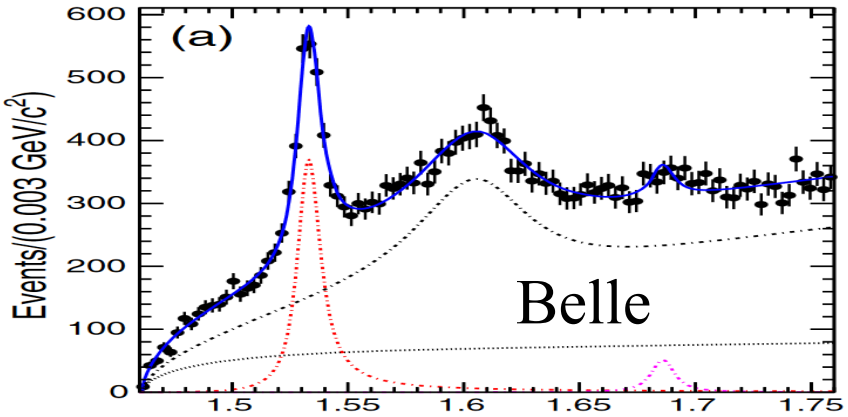
Overall best (lowest value of σ_Y/Y)



- CL > 10^{-4}
- ΔVertex > 8cm

Comparison to Belle

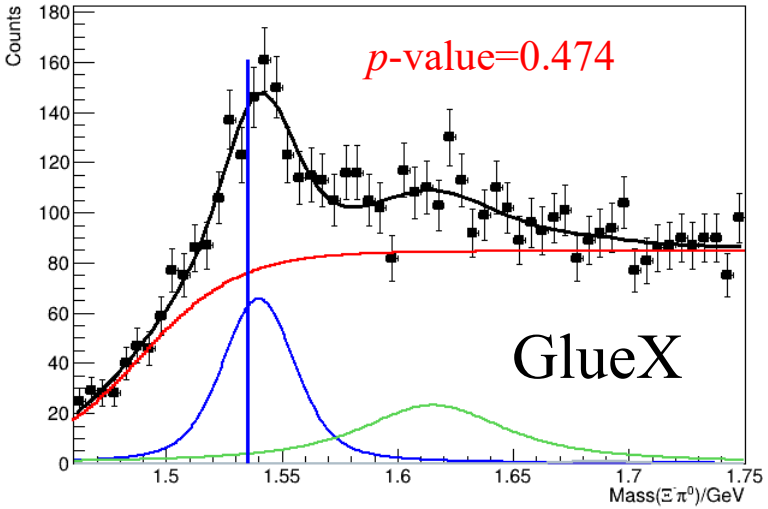


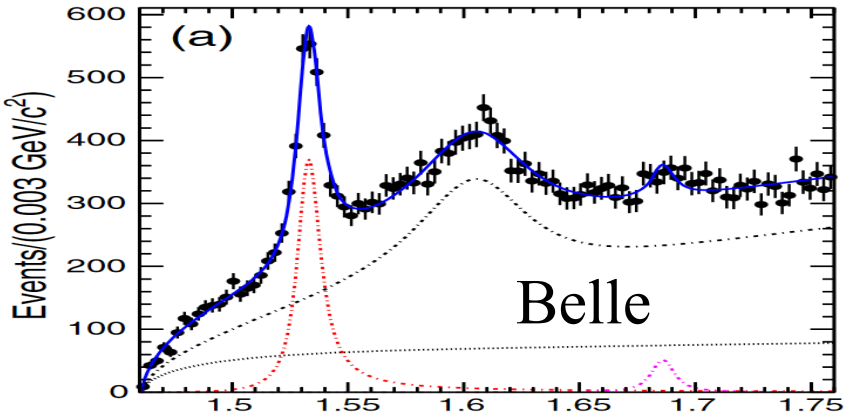


Cuts on GlueX data:

- CL>10^{-4}
- ΔVertex > 0 cm (NO ΔVertex cut)
- Ξ^- cut:
  - Kept event when
    1.30 < mass[$\Lambda\pi^-$]/GeV < 1.35
- K^* cut: None

Comparison to Belle

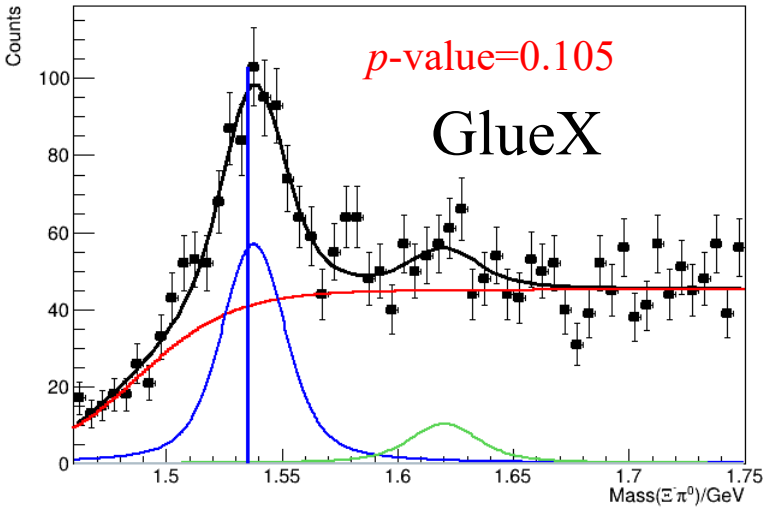


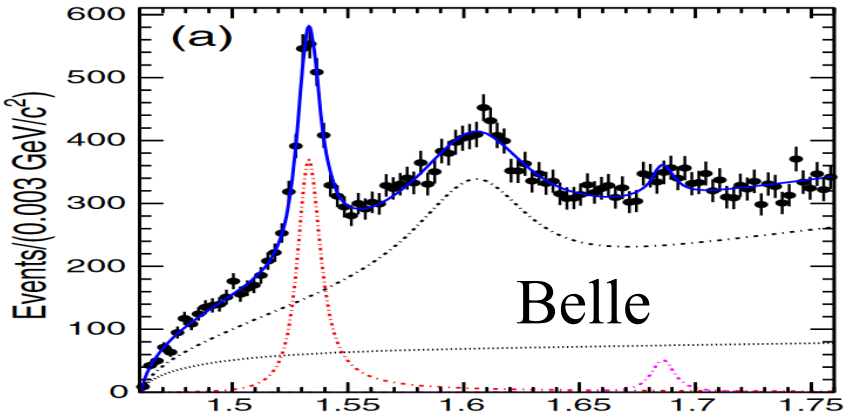


Cuts on GlueX data:

- CL>10^{-4}
- ΔVertex > 0 cm (NO ΔVertex cut)
- Ξ^- cut:
  - Kept event when
    $1.30 < \text{mass}[\Lambda\pi^-]/\text{GeV} < 1.35$
- K^* cut:
  - Remove event when
    $0.85 < \text{mass}[K^+\pi^0]/\text{GeV} < 0.95$

Comparison to Belle

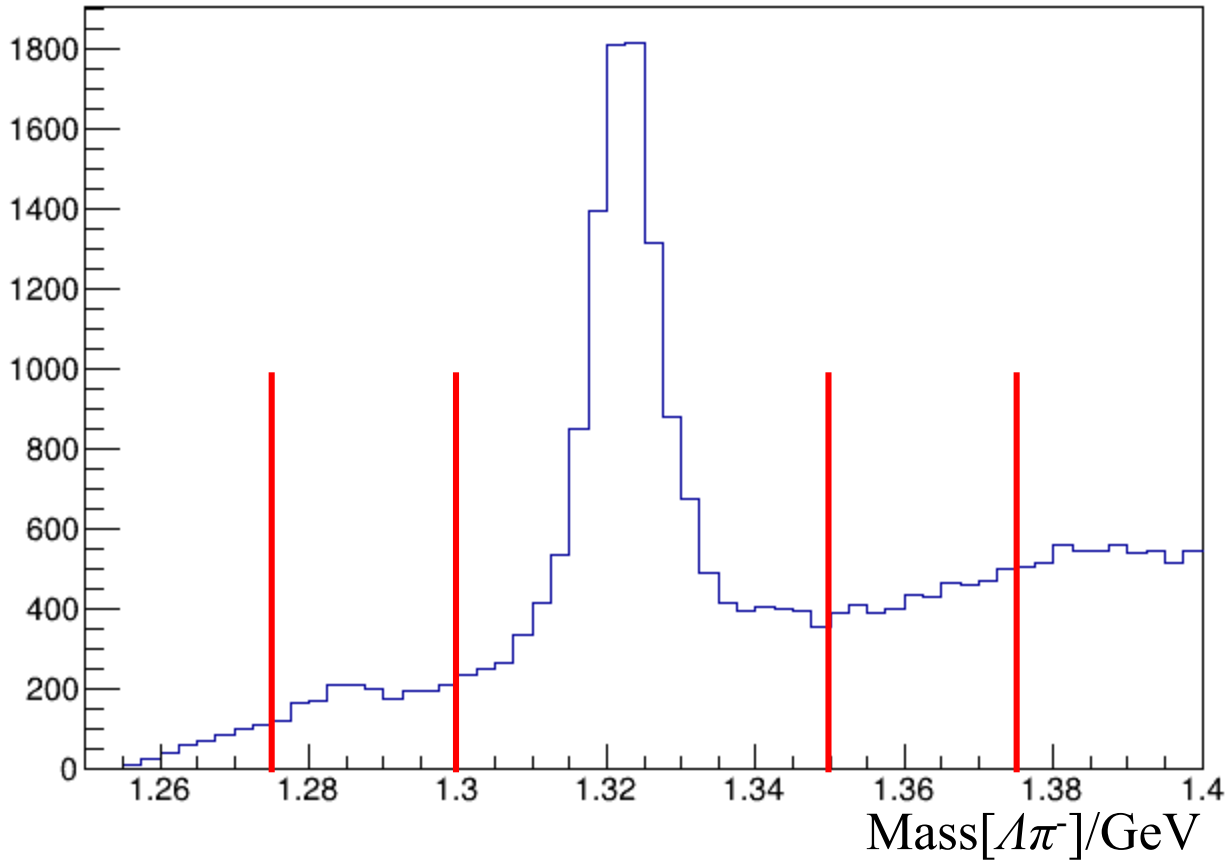




Cuts on GlueX data:

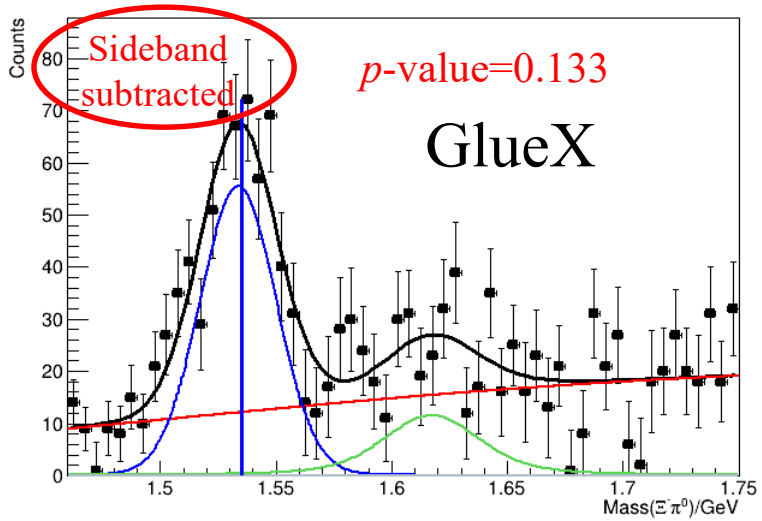
- CL>10^{-4}
- ΔVertex > 8 cm
- Ξ^- cut:
  - Kept event when
    $1.30 < \text{mass}[\Lambda\pi^-]/\text{GeV} < 1.35$
- K^* cut:
  - Remove event when
    $0.85 < \text{mass}[K^+\pi^0]/\text{GeV} < 0.95$

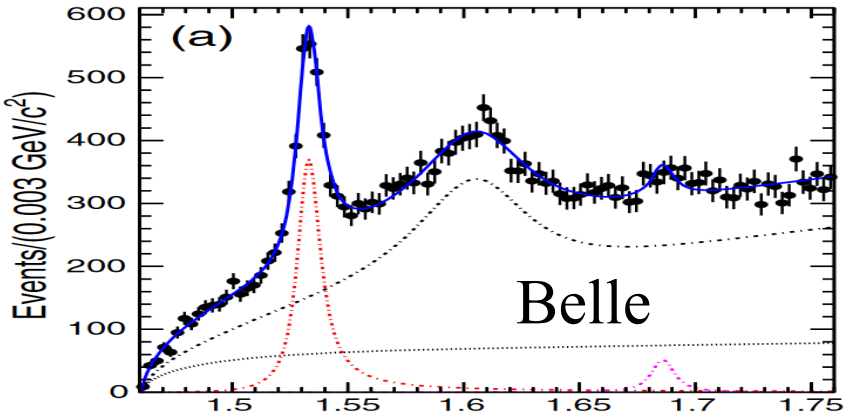
Sidebands



- CL > 10^{-4}, ΔVertex > 8cm
- For a quick background subtraction

Comparison to Belle

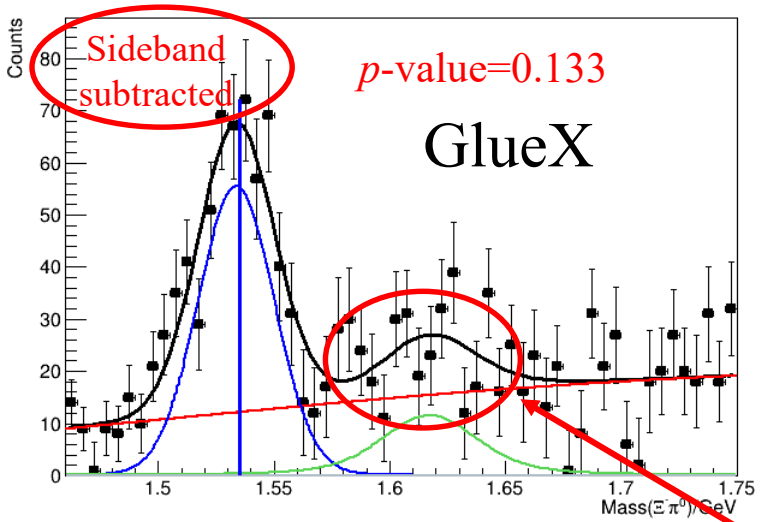


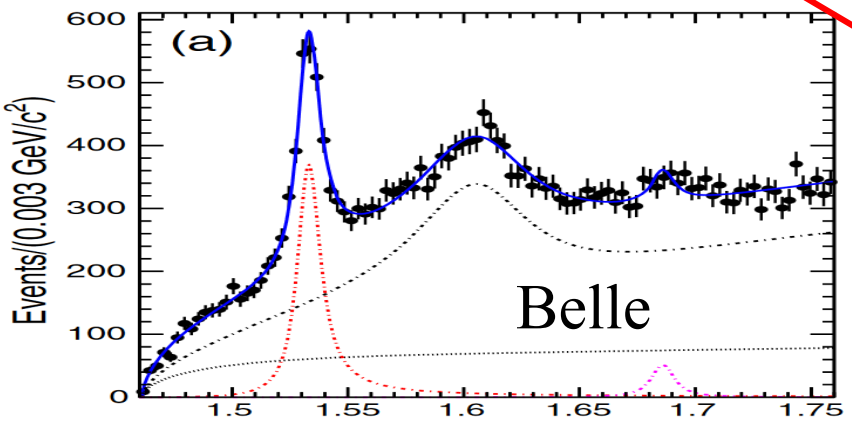


Cuts on GlueX data:

- CL>10^{-4}
- ΔVertex > 8 cm
- Ξ^- cut:
  - Kept event when
    $1.30 < \text{mass}[\Lambda\pi^-]/\text{GeV} < 1.35$
- K^* cut:
  - Remove event when
    $0.85 < \text{mass}[K^+\pi^0]/\text{GeV} < 0.9$

Comparison to Belle





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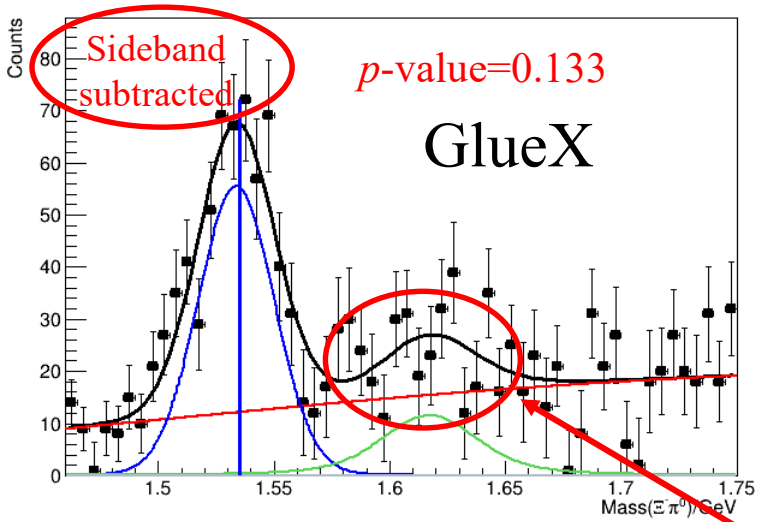
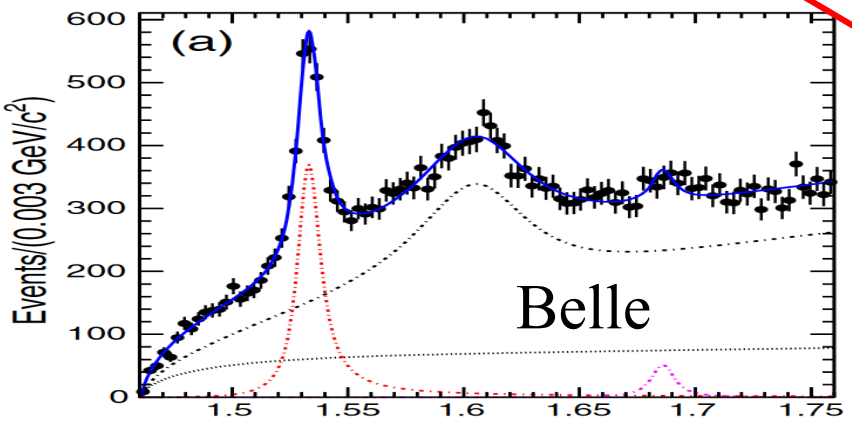
Error bars way too big with respect to bump height ☹

Comparison to Belle





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Error bars way too big with respect to bump height ☹

- The CL and ΔVertex cuts are too restrictive?
- Need a better way to choose CL and ΔVertex cuts?
- Need a better way to remove background