

E^* bump hunt III

Reaction

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

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

where

Reaction

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

$$\bar{E}^- \rightarrow \Lambda \pi$$

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

where
and

Reaction

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

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

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

where

and

- Mass of Ξ^- not constrained

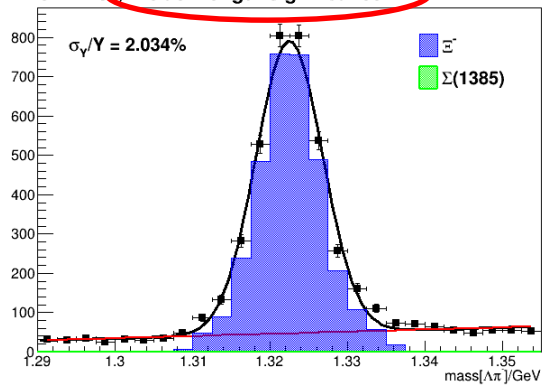
Pathlength study

- Vertex analysis now uses pathlength significance as given on page 13 of <https://halldweb.jlab.org/DocDB/0046/004607/004/DSelectorDoc.pdf>

Pathlength study

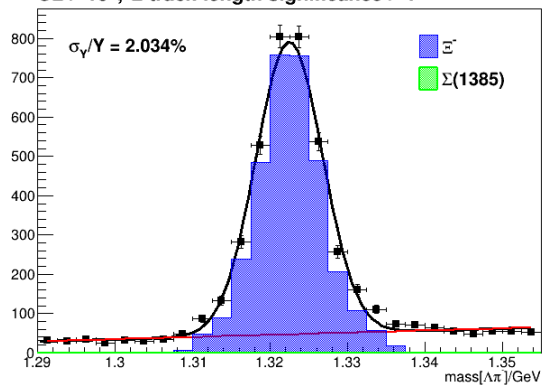
- Vertex analysis now uses pathlength significance as given on page 13 of <https://halldweb.jlab.org/DocDB/0046/004607/004/DSelectorDoc.pdf>
- As was suggested, I made sure that the end of the Ξ^- path was downstream of the origin

CL > 10⁻¹, Ξ^- track-length significance > 1

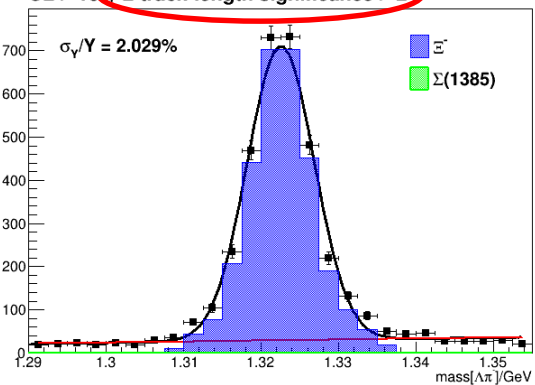


CL > 10⁻¹

CL > 10⁻¹, Ξ^- track-length significance > 1

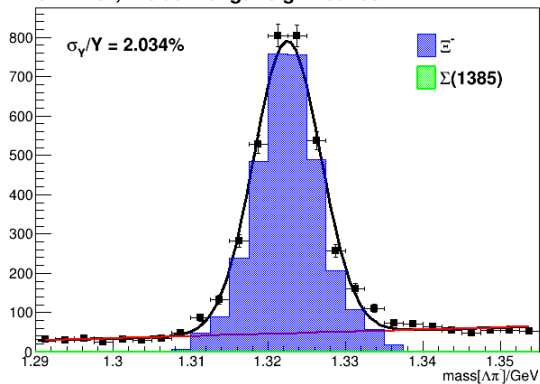


CL > 10⁻¹, Ξ^- track-length significance > 2

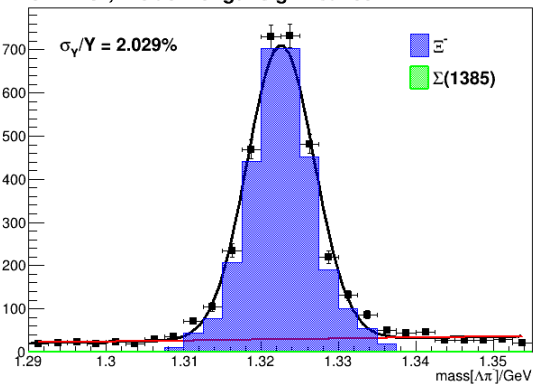


CL > 10⁻¹

CL > 10⁻¹, Ξ track-length significance > 1

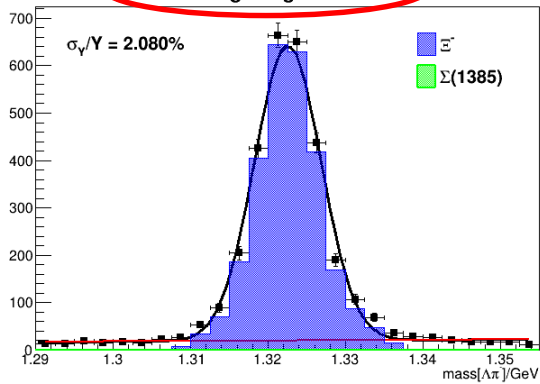


CL > 10⁻¹, Ξ track-length significance > 2

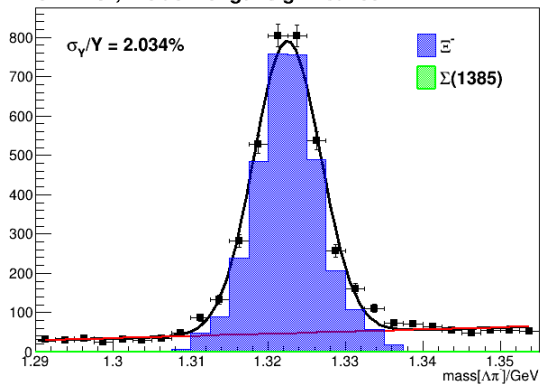


CL > 10⁻¹

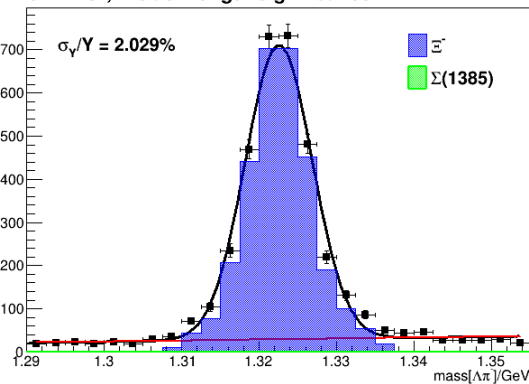
CL > 10⁻¹, Ξ track-length significance > 3



CL > 10⁻¹, Ξ track-length significance > 1

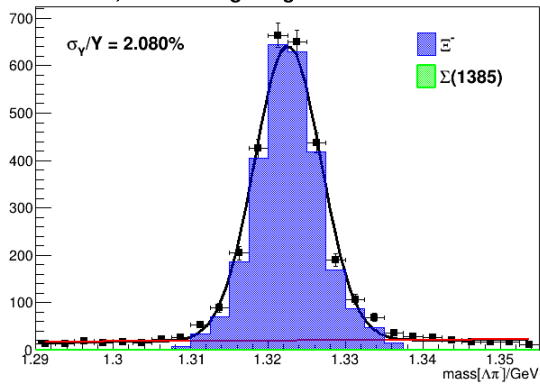


CL > 10⁻¹, Ξ track-length significance > 2

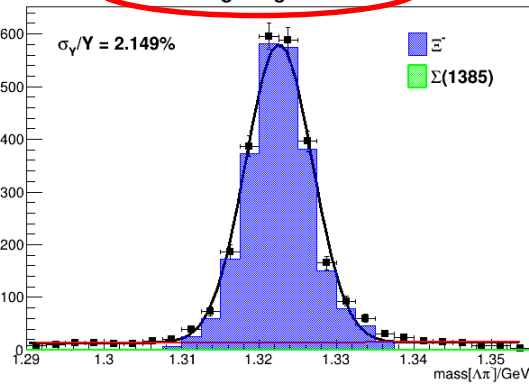


CL > 10⁻¹

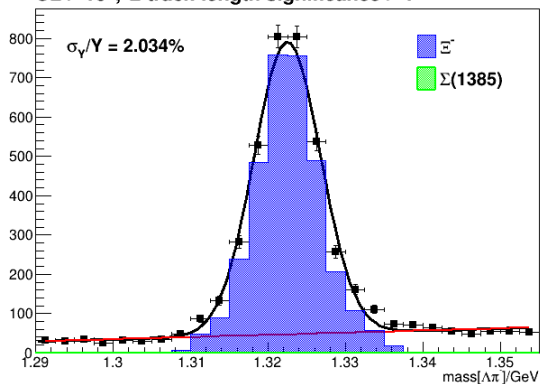
CL > 10⁻¹, Ξ track-length significance > 3



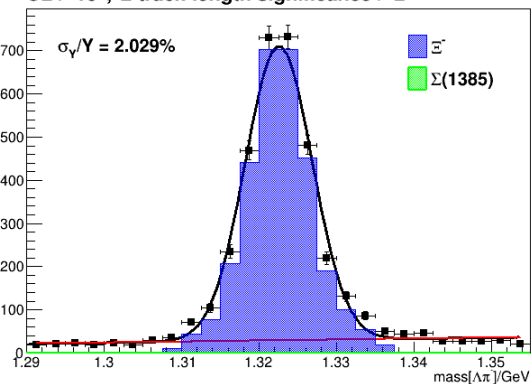
CL > 10⁻¹, Ξ track-length significance > 4



CL > 10⁻¹, Ξ track-length significance > 1

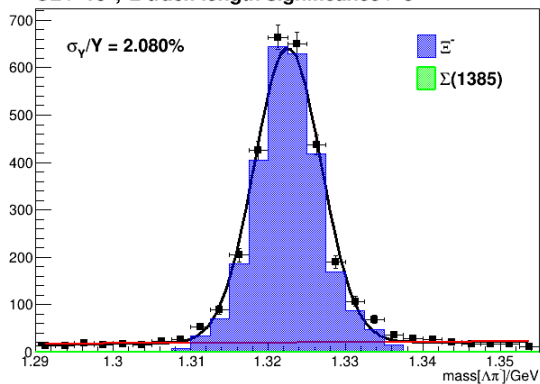


CL > 10⁻¹, Ξ track-length significance > 2

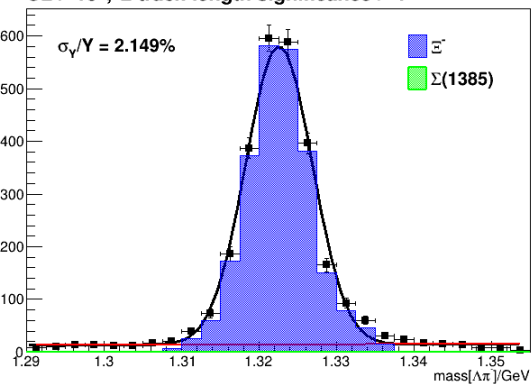


CL > 10⁻¹

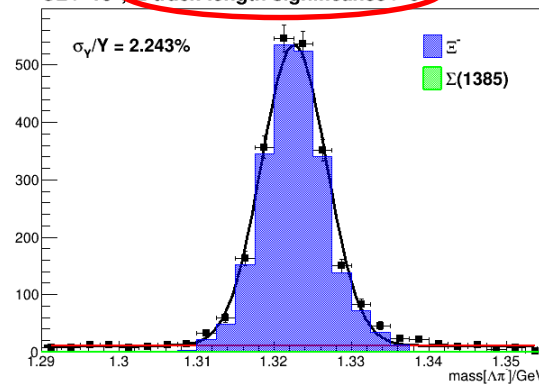
CL > 10⁻¹, Ξ track-length significance > 3



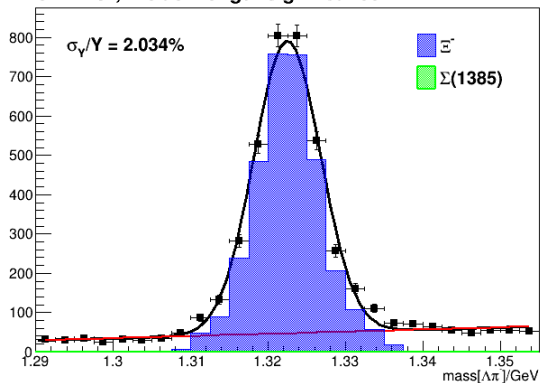
CL > 10⁻¹, Ξ track-length significance > 4



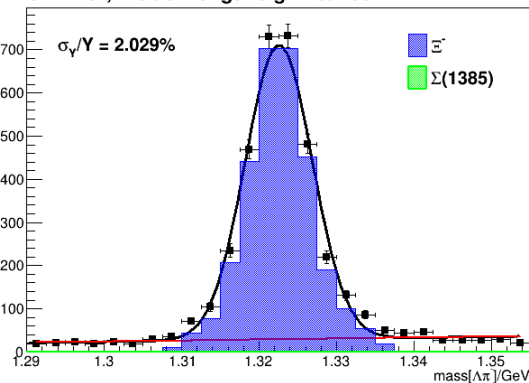
CL > 10⁻¹, Ξ track-length significance > 5



CL > 10⁻¹, Ξ track-length significance > 1

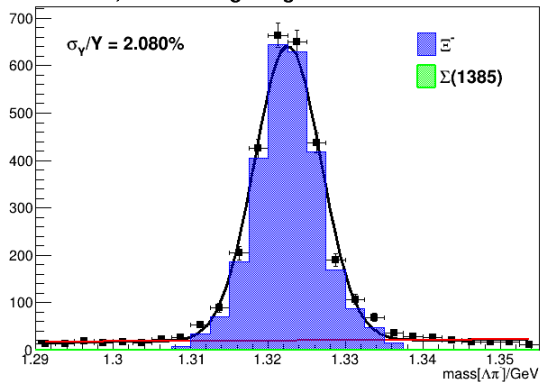


CL > 10⁻¹, Ξ track-length significance > 2

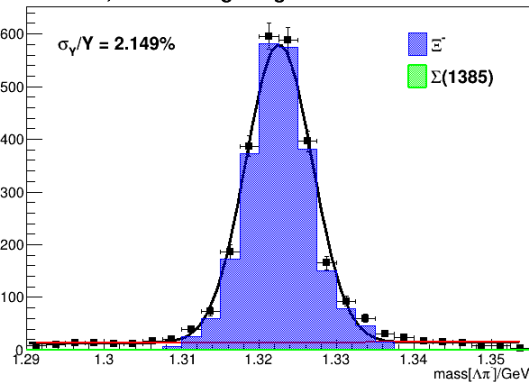


CL > 10⁻¹

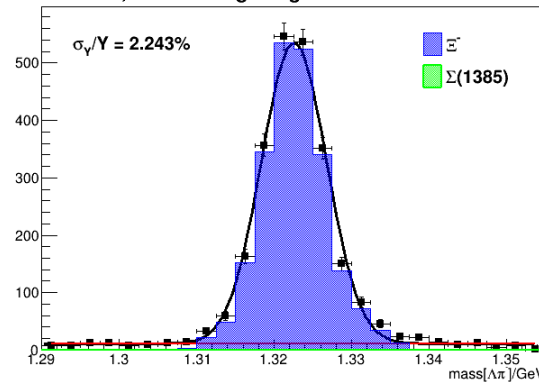
CL > 10⁻¹, Ξ track-length significance > 3



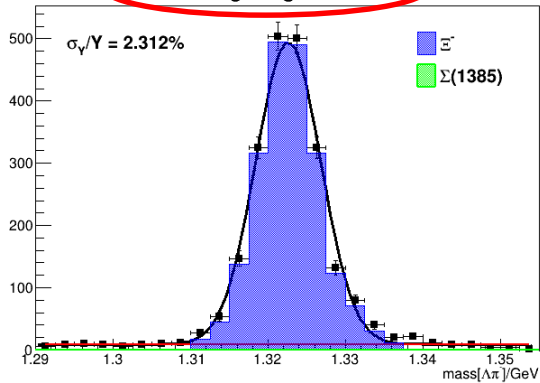
CL > 10⁻¹, Ξ track-length significance > 4



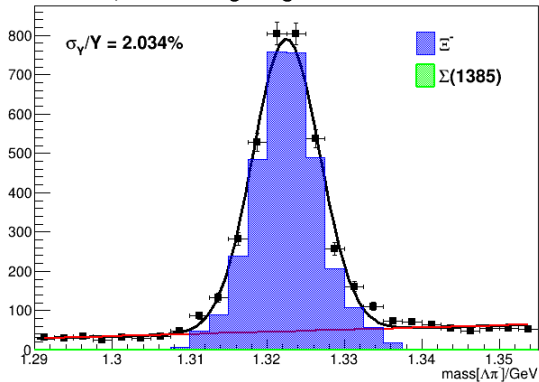
CL > 10⁻¹, Ξ track-length significance > 5



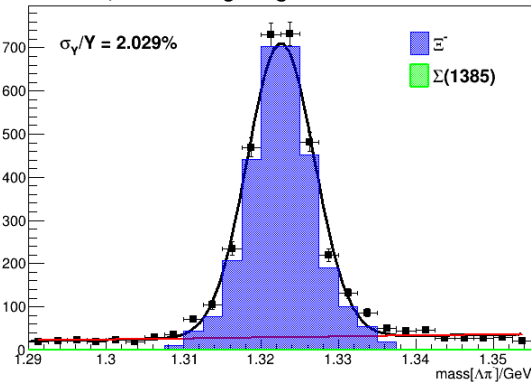
CL > 10⁻¹, Ξ track-length significance > 6



CL > 10⁻¹, Ξ track-length significance > 1

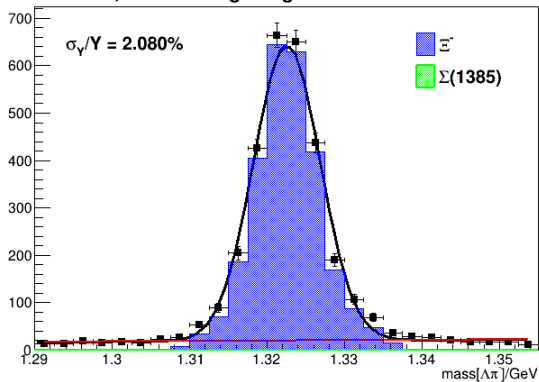


CL > 10⁻¹, Ξ track-length significance > 2

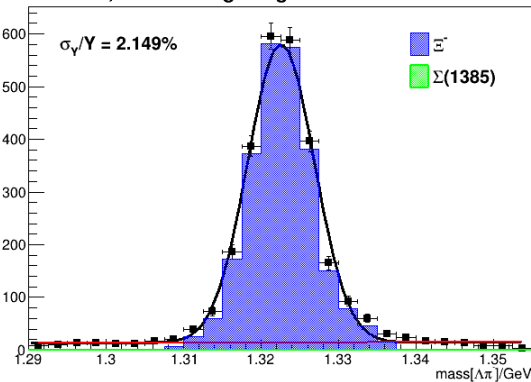


CL > 10⁻¹

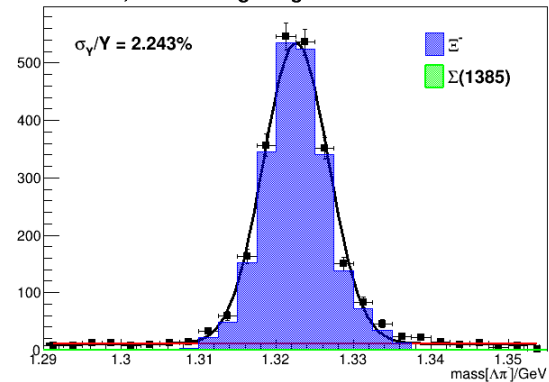
CL > 10⁻¹, Ξ track-length significance > 3



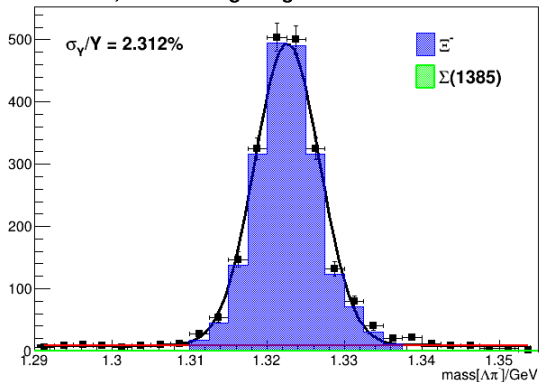
CL > 10⁻¹, Ξ track-length significance > 4



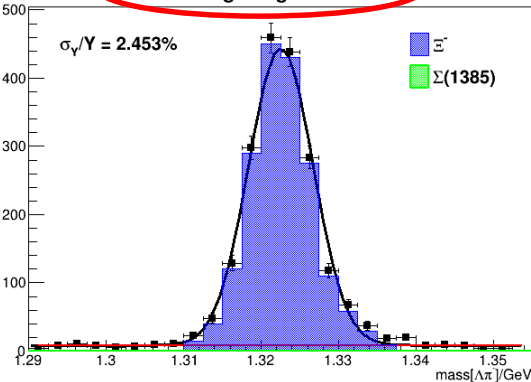
CL > 10⁻¹, Ξ track-length significance > 5



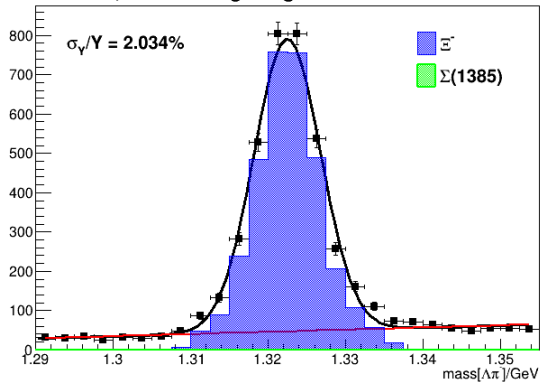
CL > 10⁻¹, Ξ track-length significance > 6



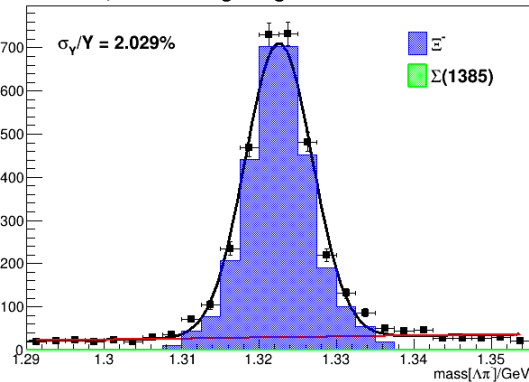
CL > 10⁻¹, Ξ track-length significance > 7



CL > 10⁻¹, Ξ track-length significance > 1

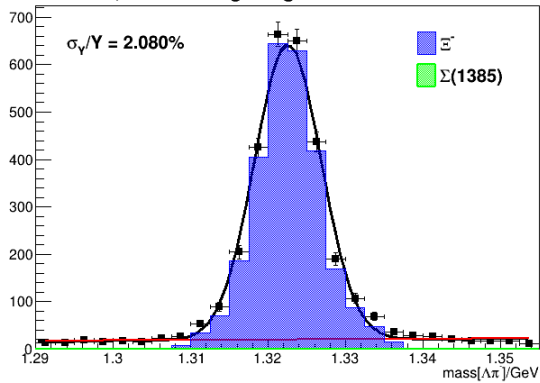


CL > 10⁻¹, Ξ track-length significance > 2

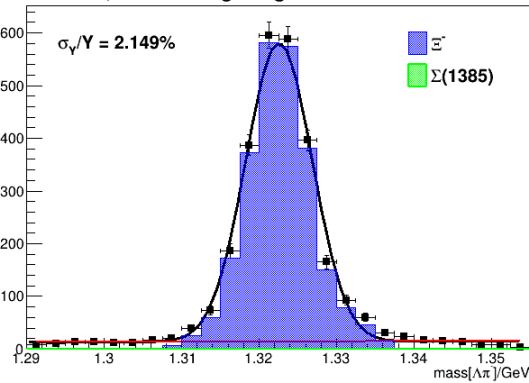


CL > 10⁻¹

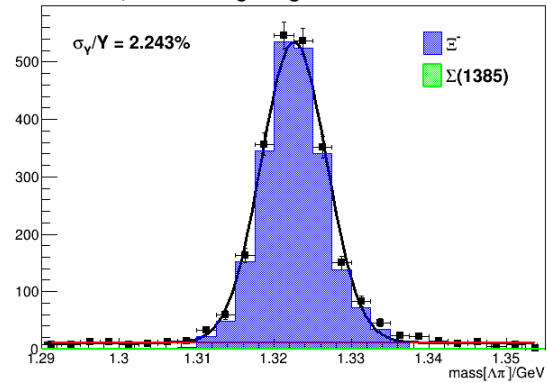
CL > 10⁻¹, Ξ track-length significance > 3



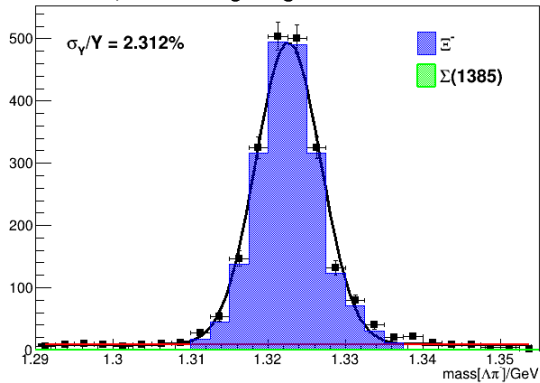
CL > 10⁻¹, Ξ track-length significance > 4



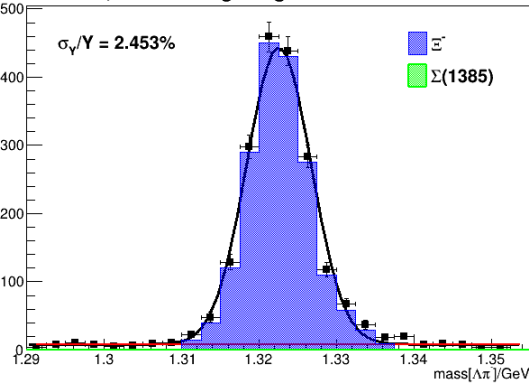
CL > 10⁻¹, Ξ track-length significance > 5



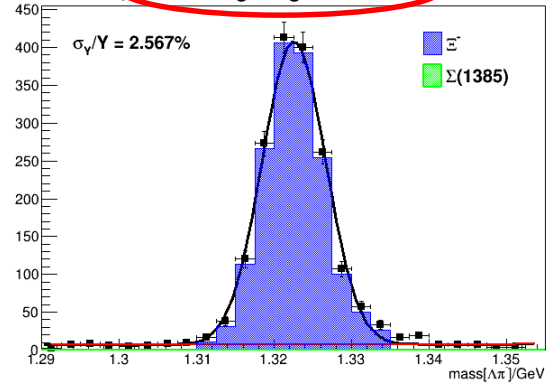
CL > 10⁻¹, Ξ track-length significance > 6



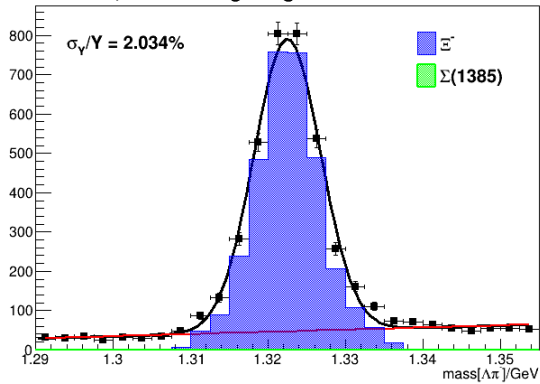
CL > 10⁻¹, Ξ track-length significance > 7



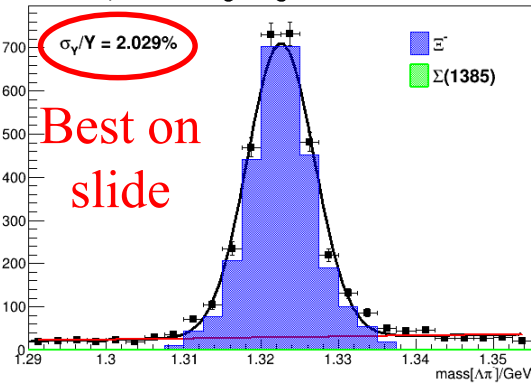
CL > 10⁻¹, Ξ track-length significance > 8



CL > 10⁻¹, Ξ track-length significance > 1

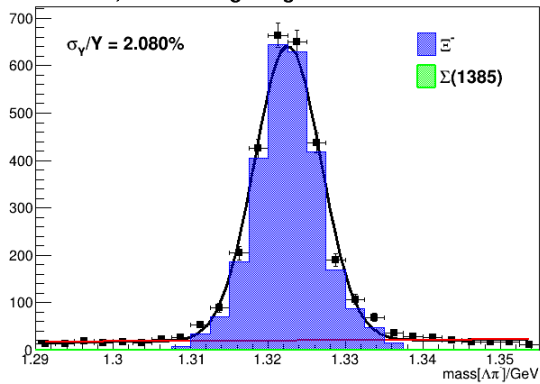


CL > 10⁻¹, Ξ track-length significance > 2

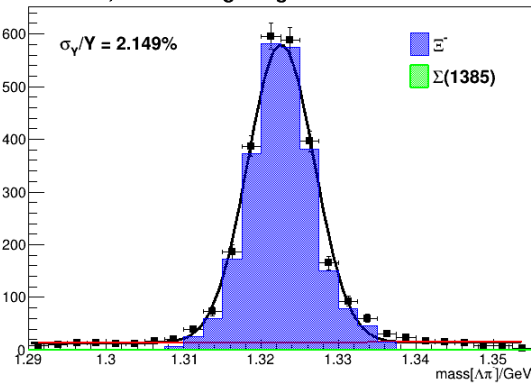


CL > 10⁻¹

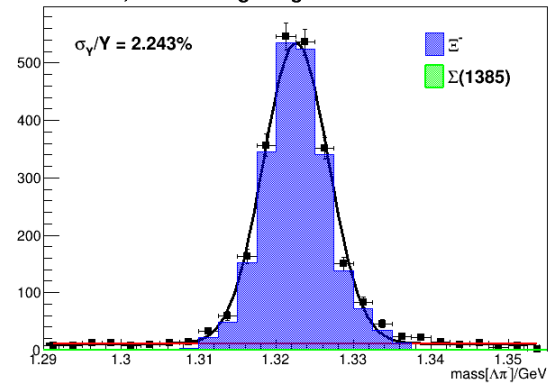
CL > 10⁻¹, Ξ track-length significance > 3



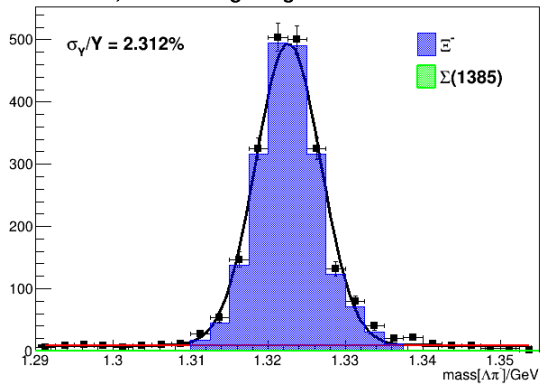
CL > 10⁻¹, Ξ track-length significance > 4



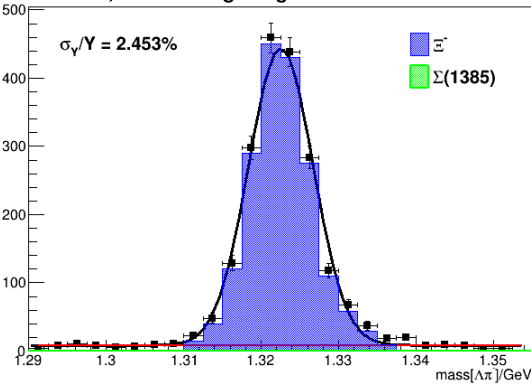
CL > 10⁻¹, Ξ track-length significance > 5



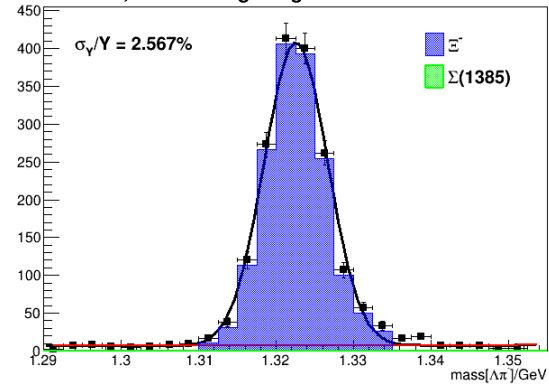
CL > 10⁻¹, Ξ track-length significance > 6



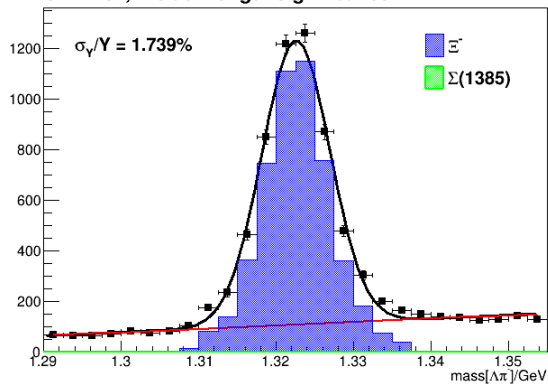
CL > 10⁻¹, Ξ track-length significance > 7



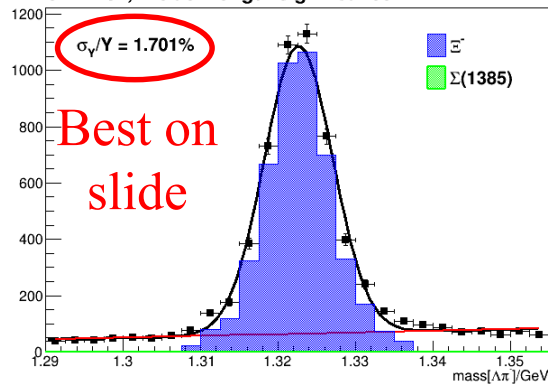
CL > 10⁻¹, Ξ track-length significance > 8



CL > 10⁻², Ξ track-length significance > 1

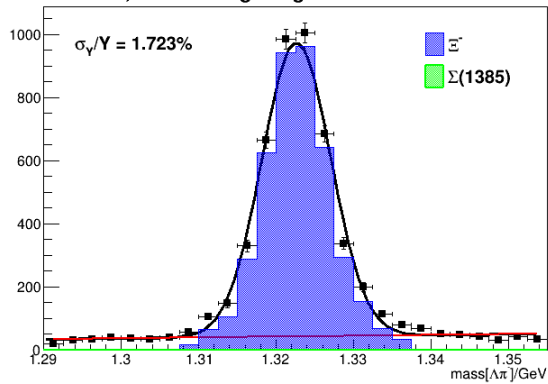


CL > 10⁻², Ξ track-length significance > 2

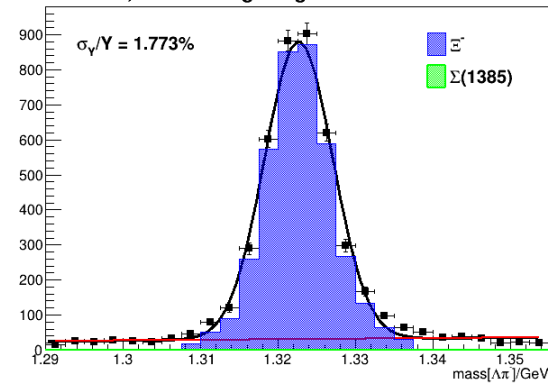


CL > 10⁻²

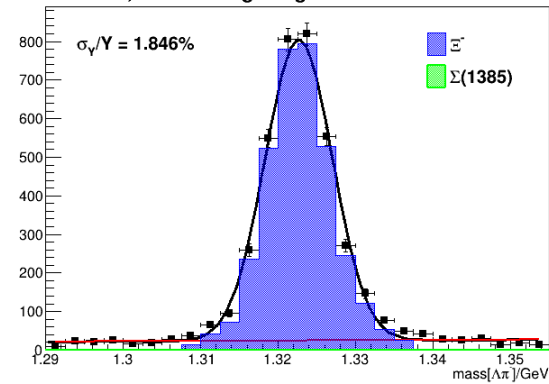
CL > 10⁻², Ξ track-length significance > 3



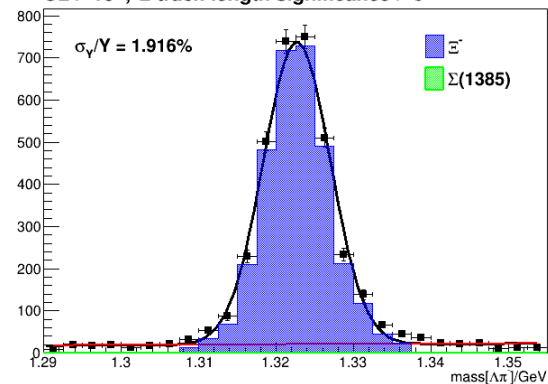
CL > 10⁻², Ξ track-length significance > 4



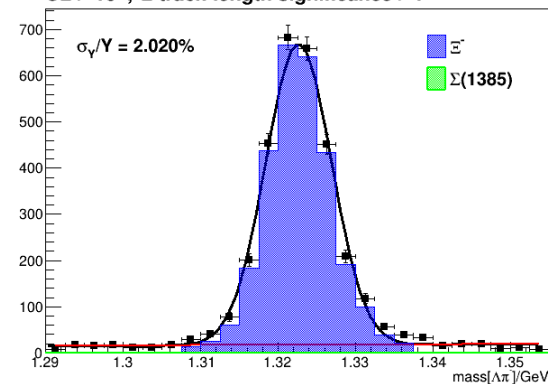
CL > 10⁻², Ξ track-length significance > 5



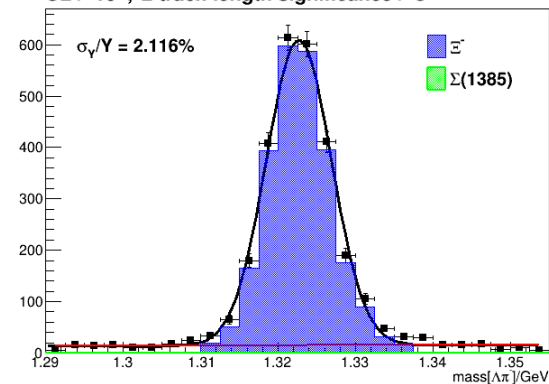
CL > 10⁻², Ξ track-length significance > 6



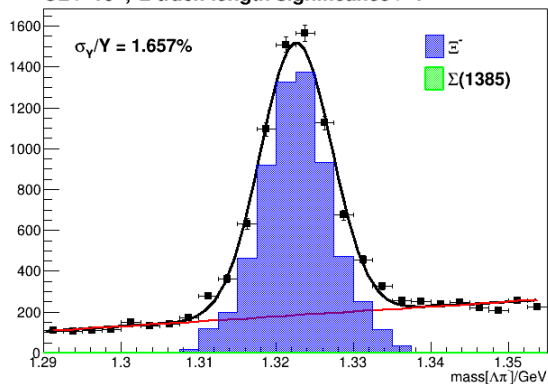
CL > 10⁻², Ξ track-length significance > 7



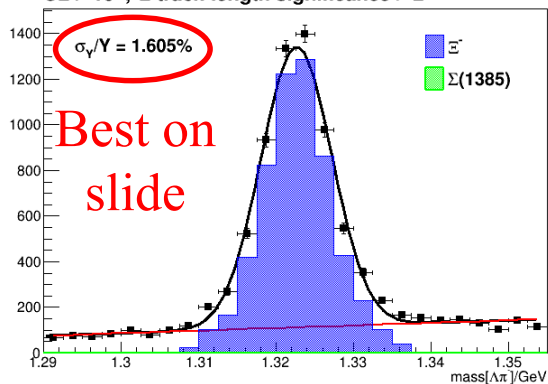
CL > 10⁻², Ξ track-length significance > 8



CL > 10⁻³, Ξ track-length significance > 1

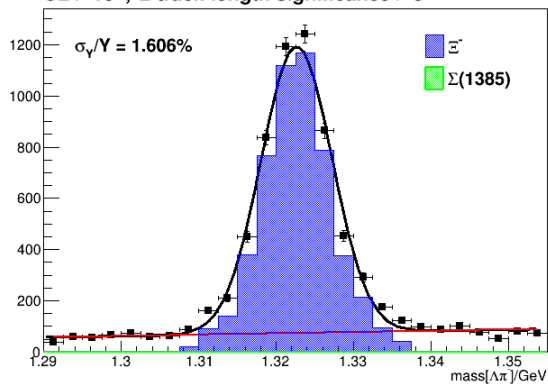


CL > 10⁻³, Ξ track-length significance > 2

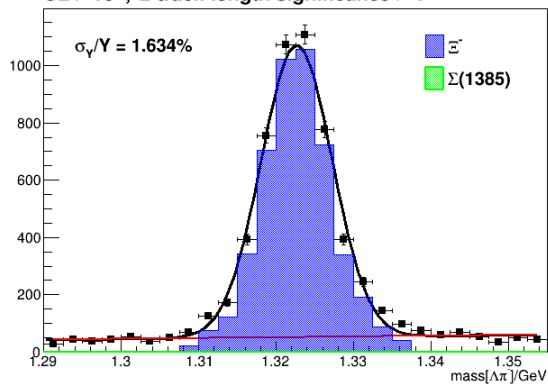


CL > 10⁻³

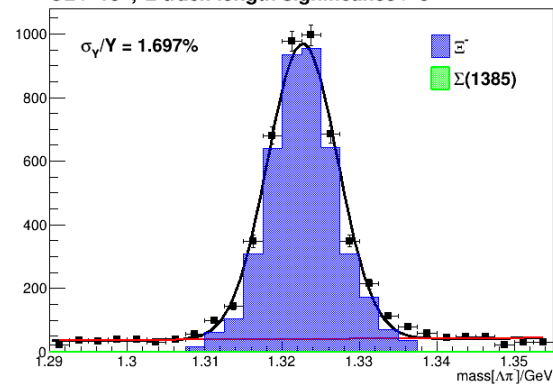
CL > 10⁻³, Ξ track-length significance > 3



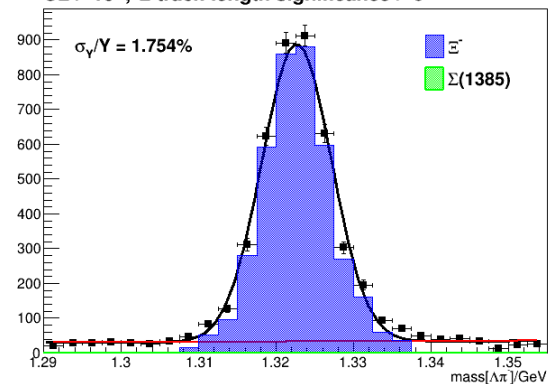
CL > 10⁻³, Ξ track-length significance > 4



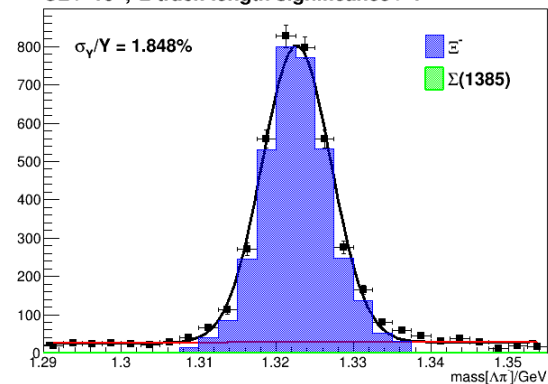
CL > 10⁻³, Ξ track-length significance > 5



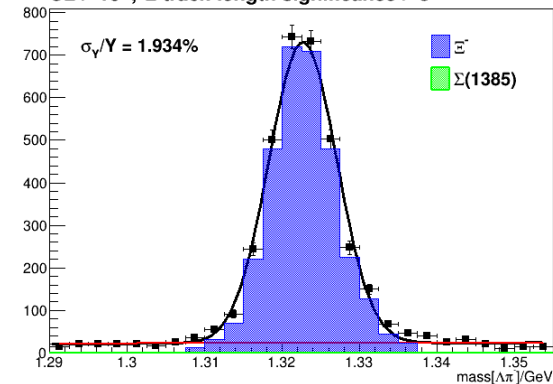
CL > 10⁻³, Ξ track-length significance > 6



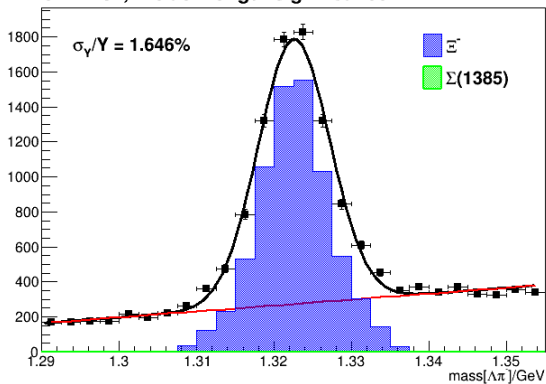
CL > 10⁻³, Ξ track-length significance > 7



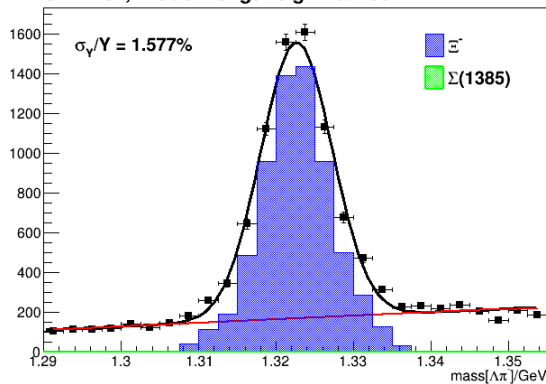
CL > 10⁻³, Ξ track-length significance > 8



CL > 10⁻⁴, Ξ track-length significance > 1

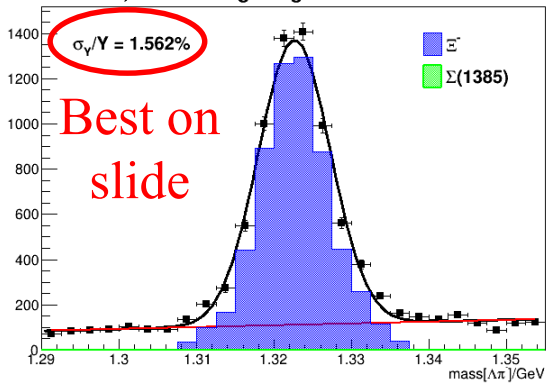


CL > 10⁻⁴, Ξ track-length significance > 2

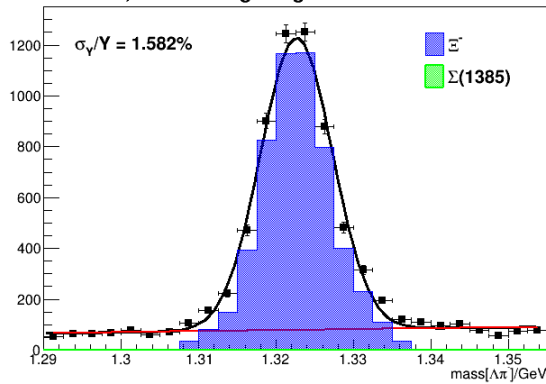


CL > 10⁻⁴

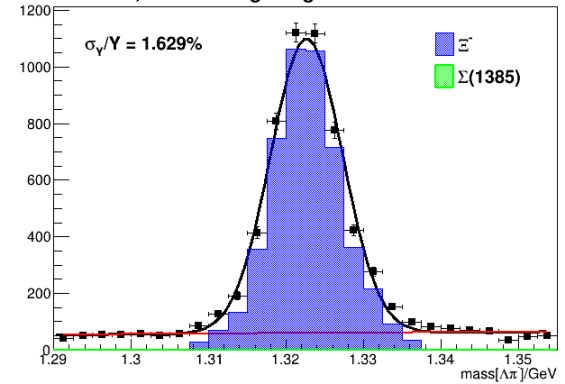
CL > 10⁻⁴, Ξ track-length significance > 3



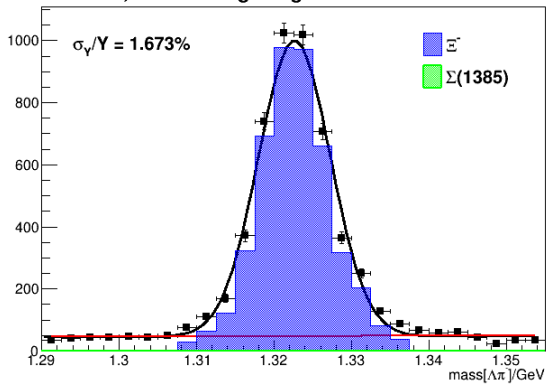
CL > 10⁻⁴, Ξ track-length significance > 4



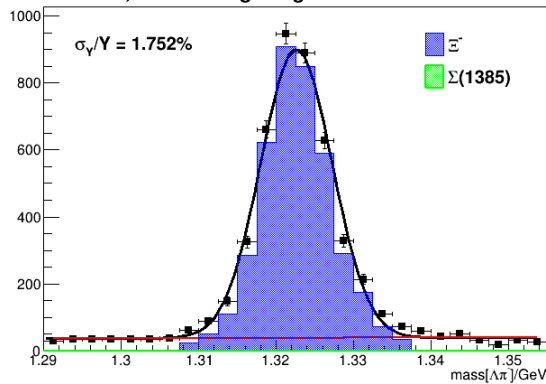
CL > 10⁻⁴, Ξ track-length significance > 5



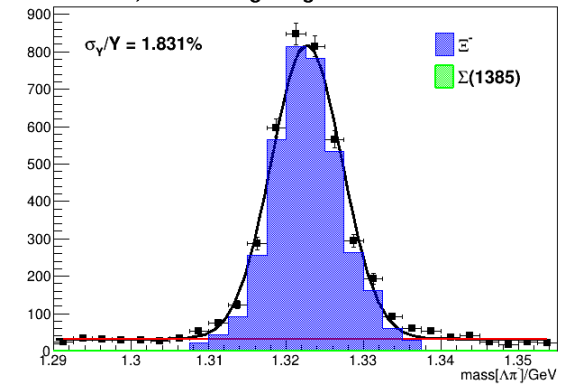
CL > 10⁻⁴, Ξ track-length significance > 6



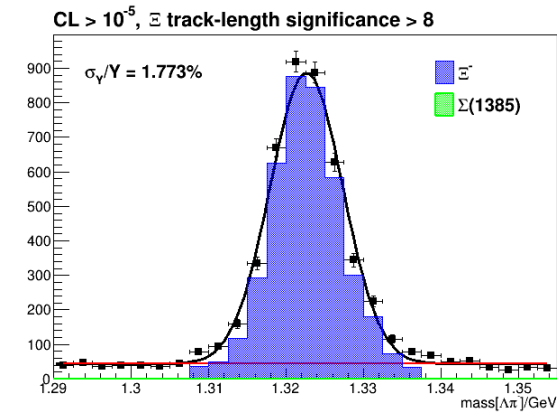
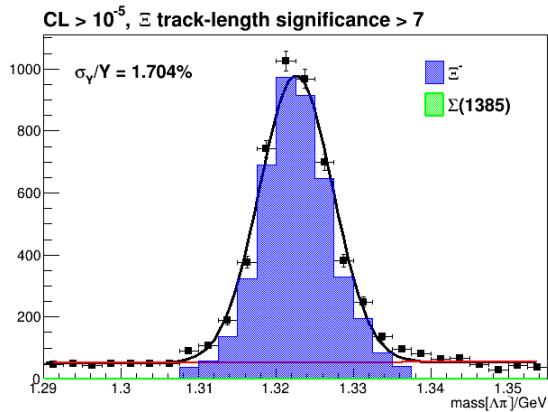
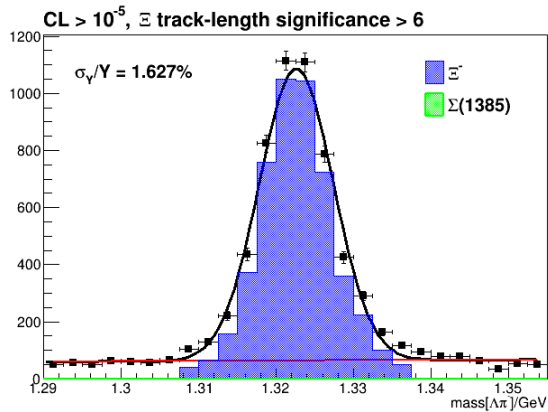
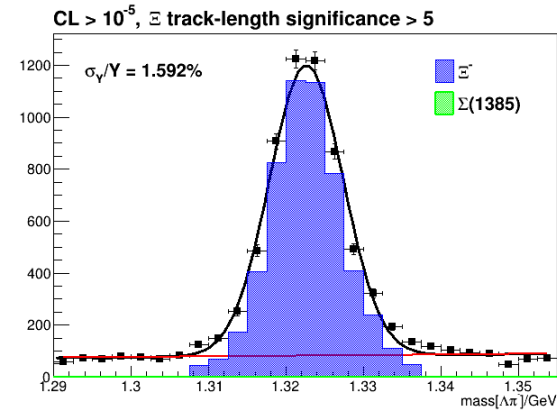
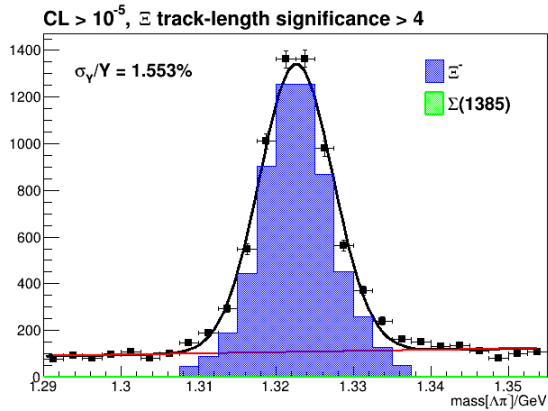
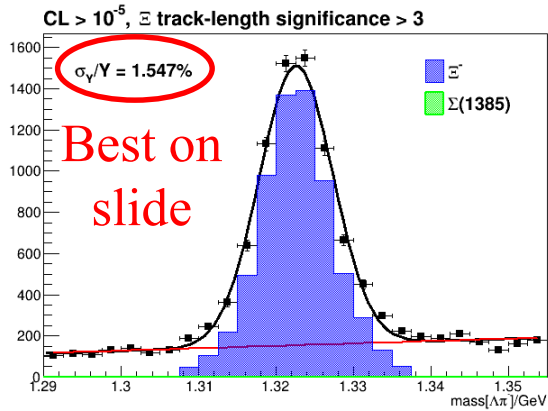
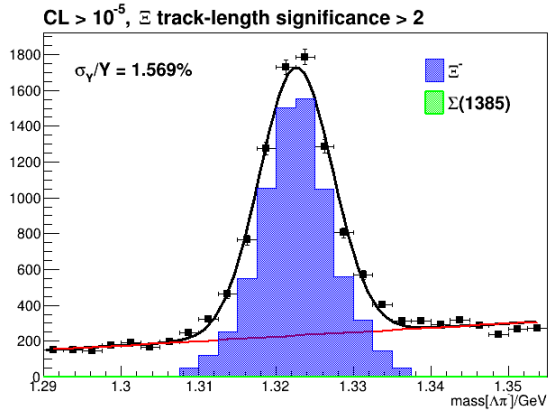
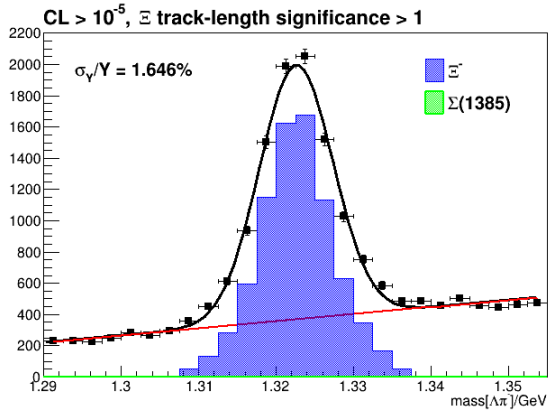
CL > 10⁻⁴, Ξ track-length significance > 7



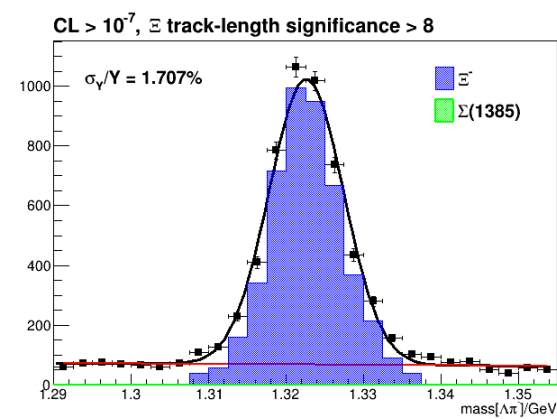
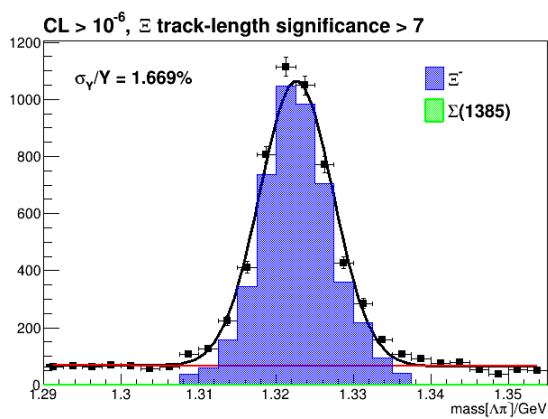
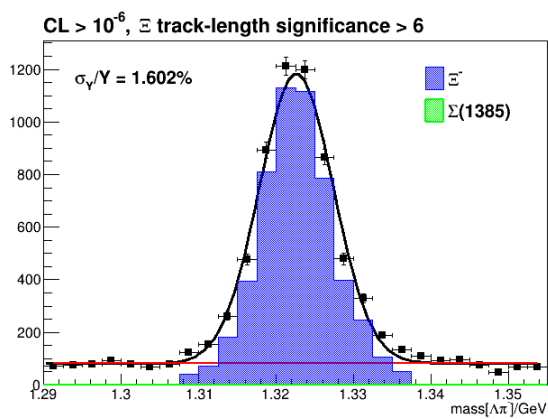
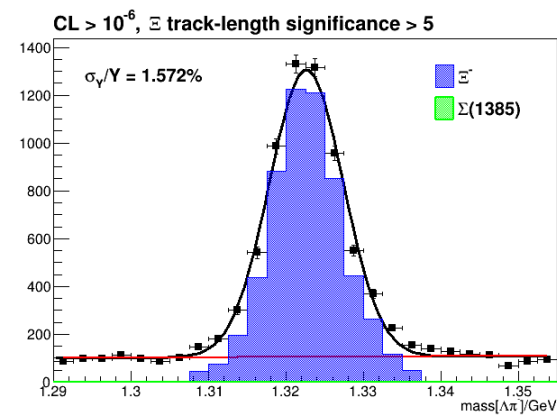
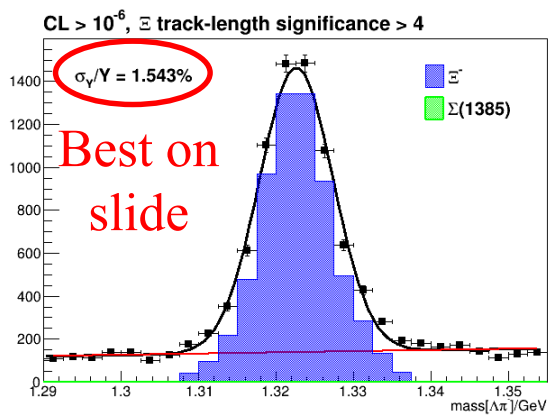
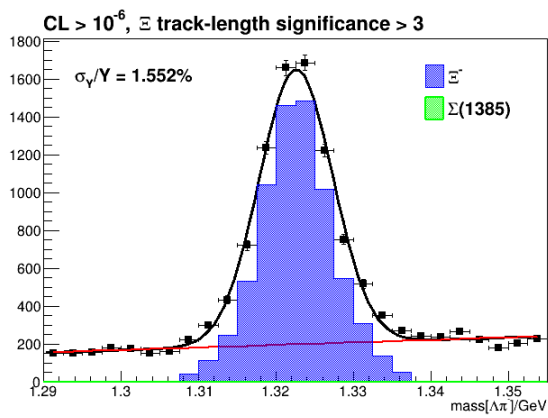
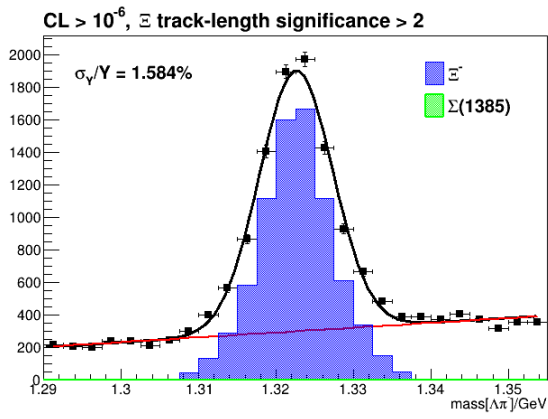
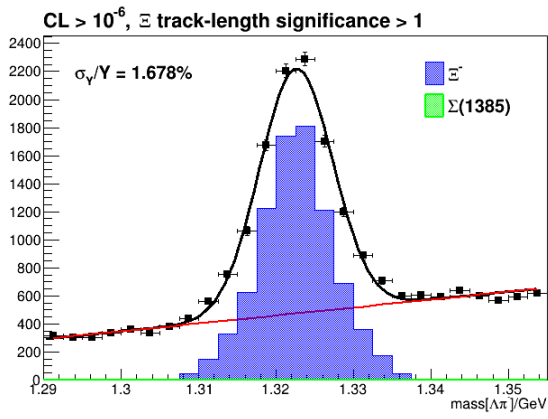
CL > 10⁻⁴, Ξ track-length significance > 8



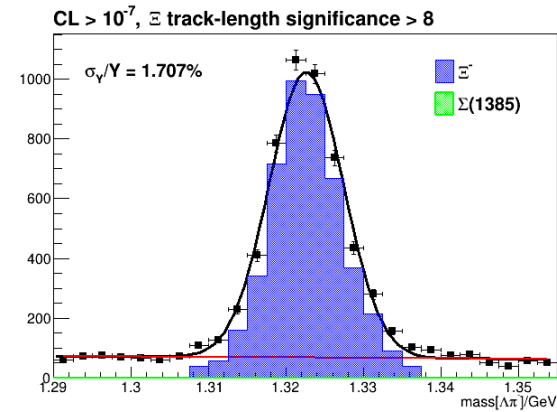
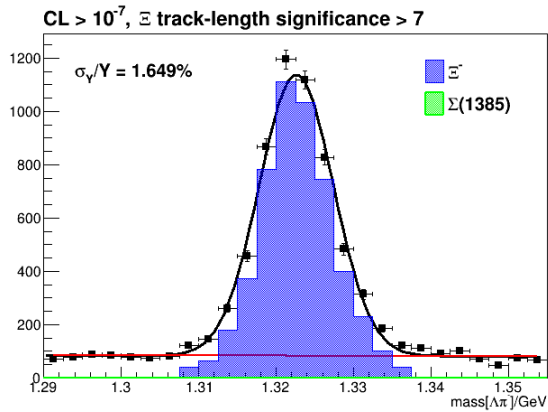
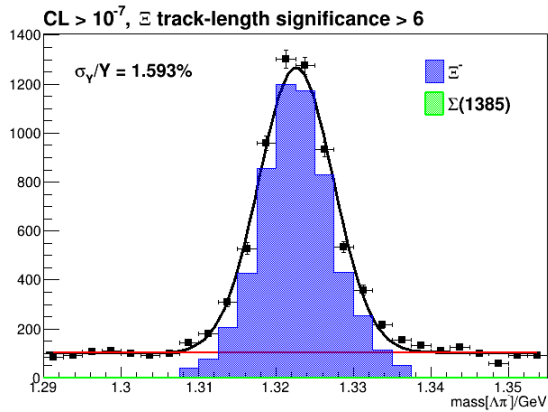
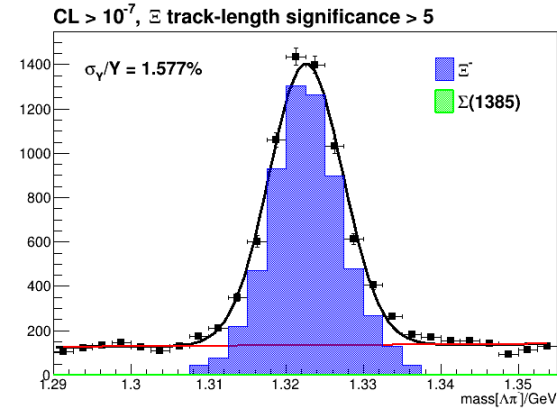
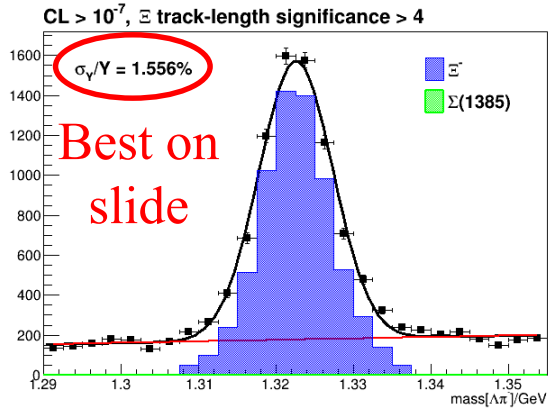
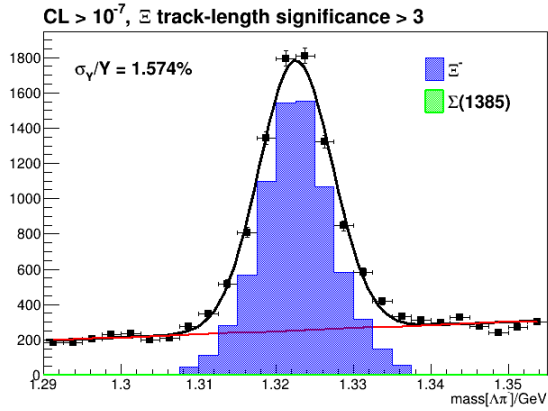
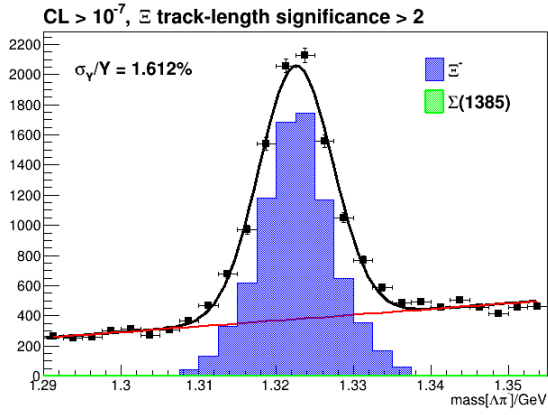
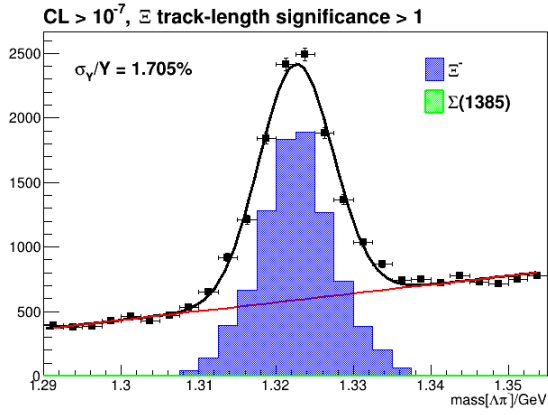
$CL > 10^{-5}$



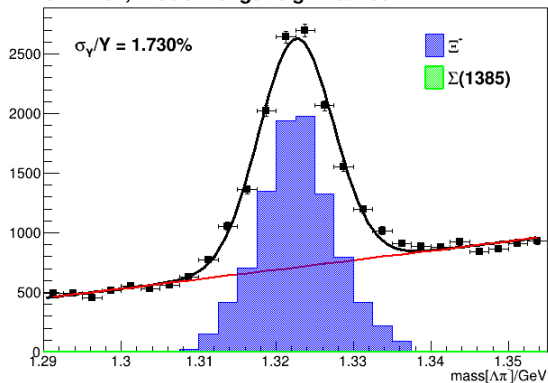
CL > 10⁻⁶



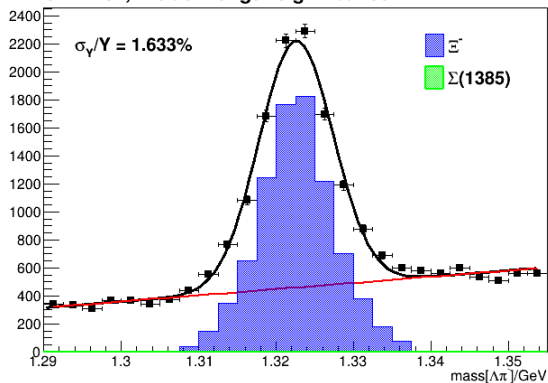
$CL > 10^{-7}$



CL > 10⁻⁸, Ξ track-length significance > 1

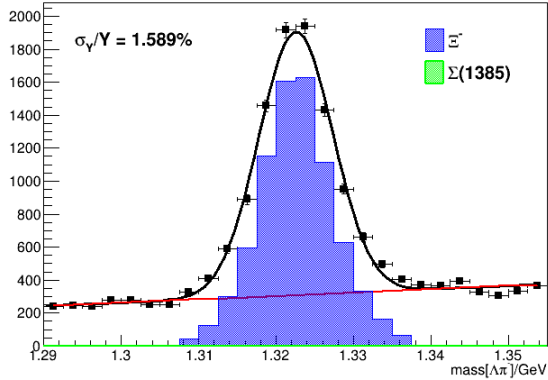


CL > 10⁻⁸, Ξ track-length significance > 2

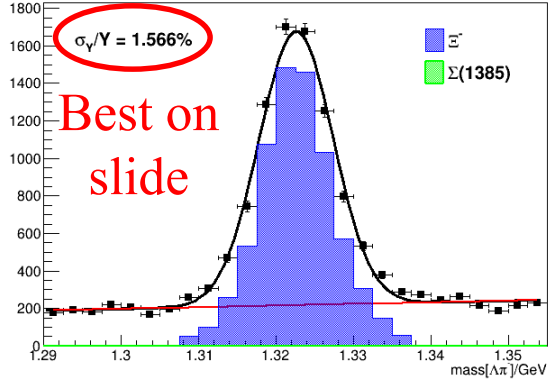


CL > 10⁻⁸

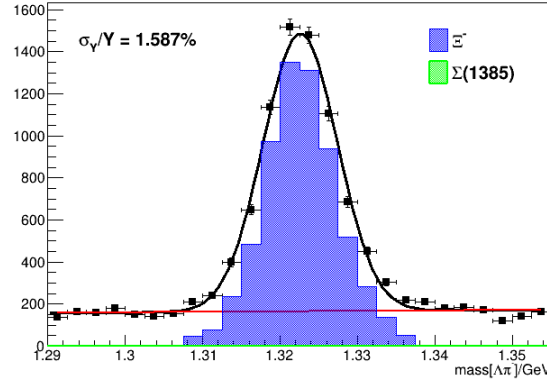
CL > 10⁻⁸, Ξ track-length significance > 3



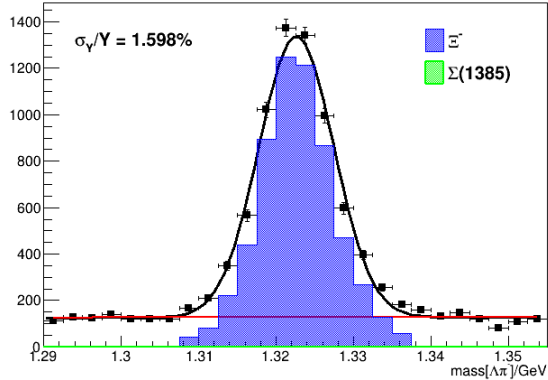
CL > 10⁻⁸, Ξ track-length significance > 4



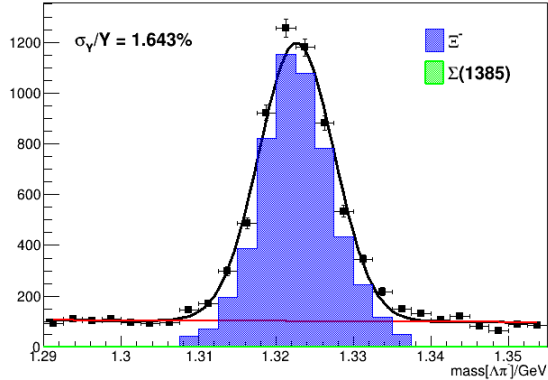
CL > 10⁻⁸, Ξ track-length significance > 5



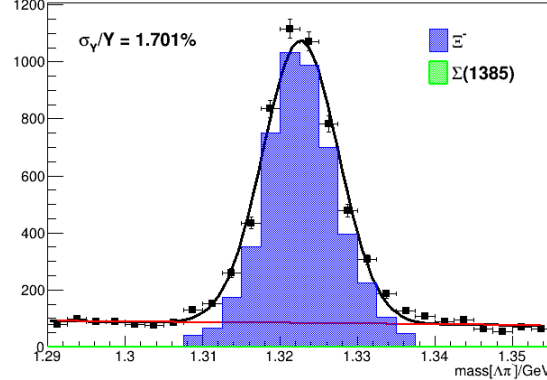
CL > 10⁻⁸, Ξ track-length significance > 6



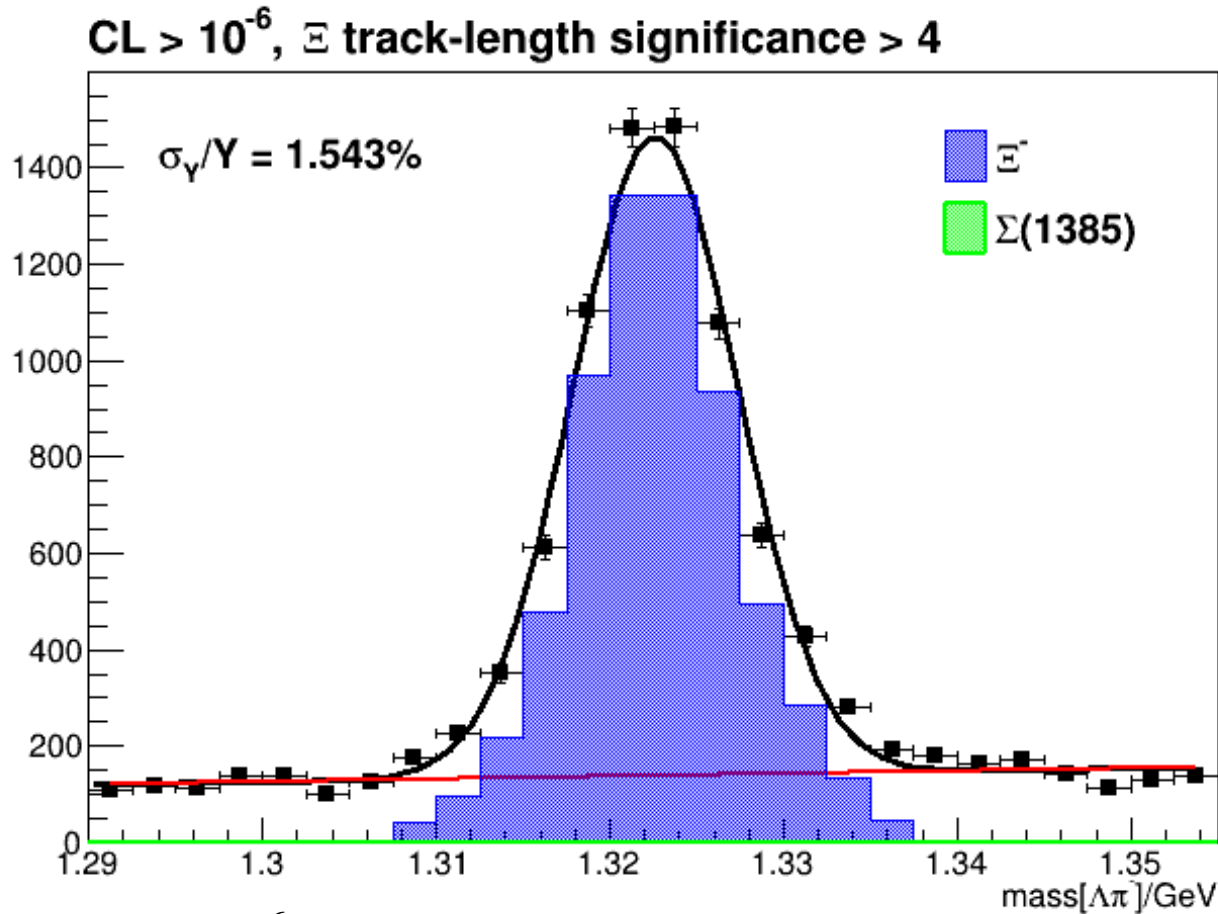
CL > 10⁻⁸, Ξ track-length significance > 7



CL > 10⁻⁸, Ξ track-length significance > 8



Overall best (lowest value of σ_Y/Y)



- CL > 10⁻⁶
- Ξ track-length significance > 4

Monte Carlo

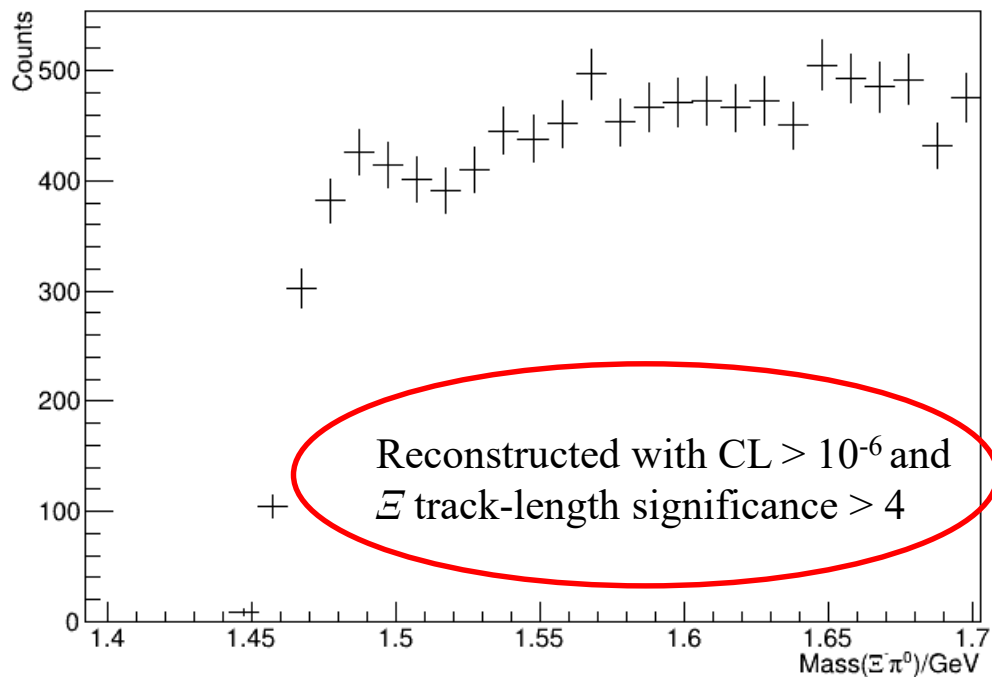
- Threw 3.4 million events (so far)

Monte Carlo

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- Generated flat in mass [$E^- \pi^0$] from 1.46 GeV to 1.75 GeV

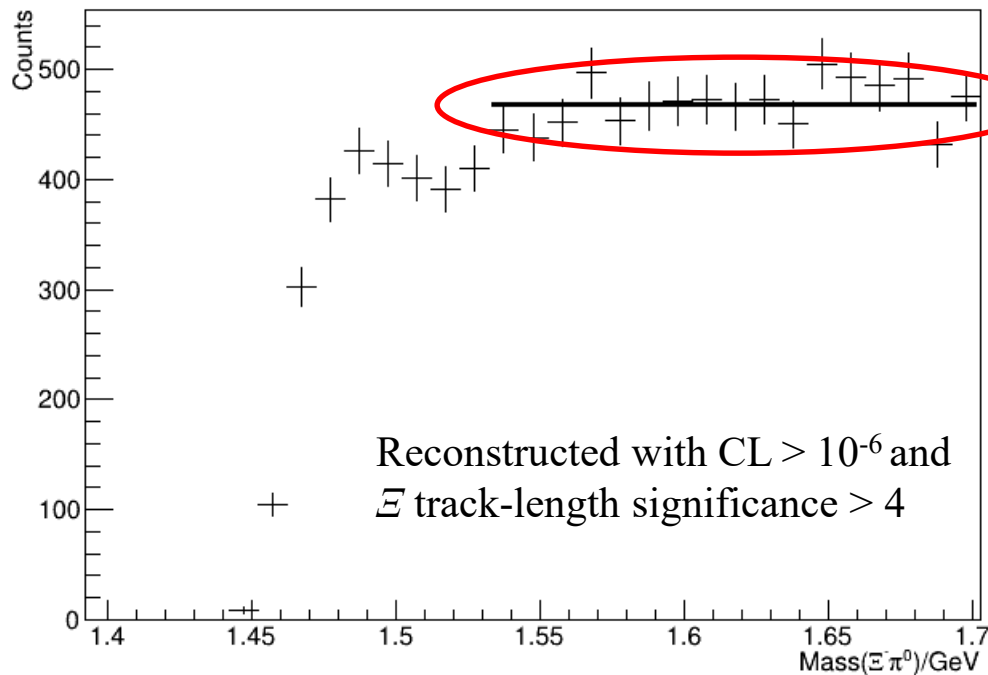
Monte Carlo

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Monte Carlo

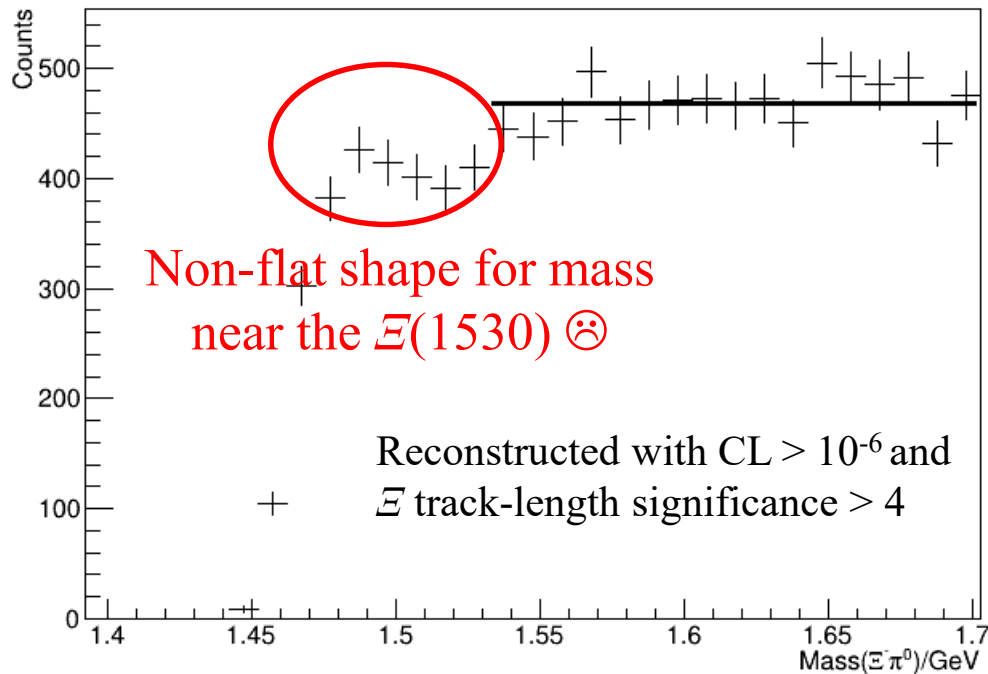
- Threw 3.4 million events (so far)
- Generated flat in mass [$\Xi^-\pi^0$] from 1.46 GeV to 1.75 GeV



Fairly flat for
mass > 1.54 GeV

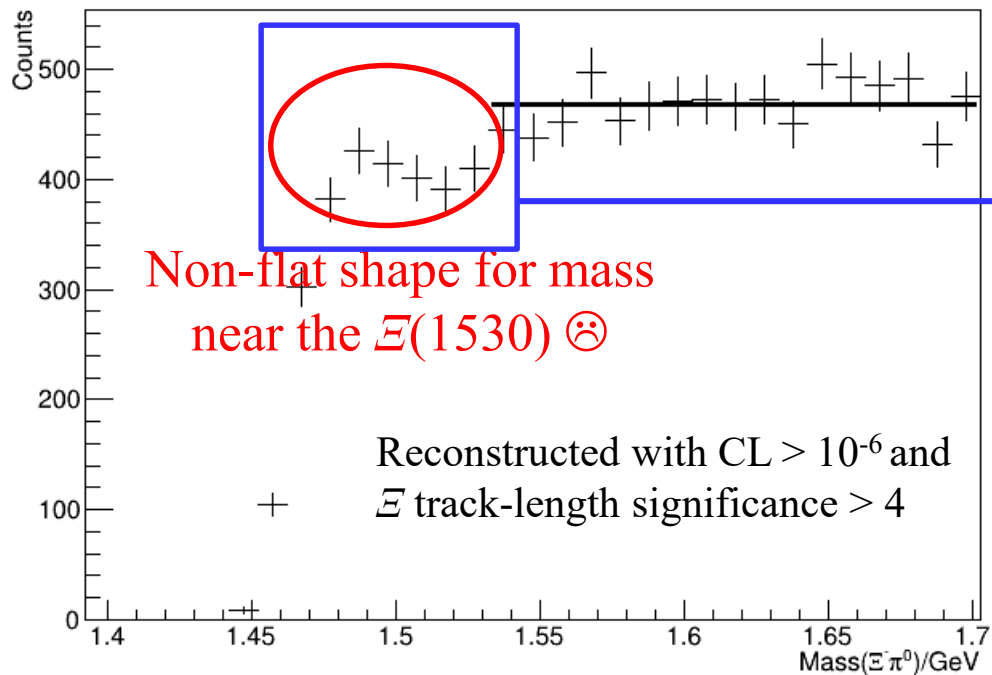
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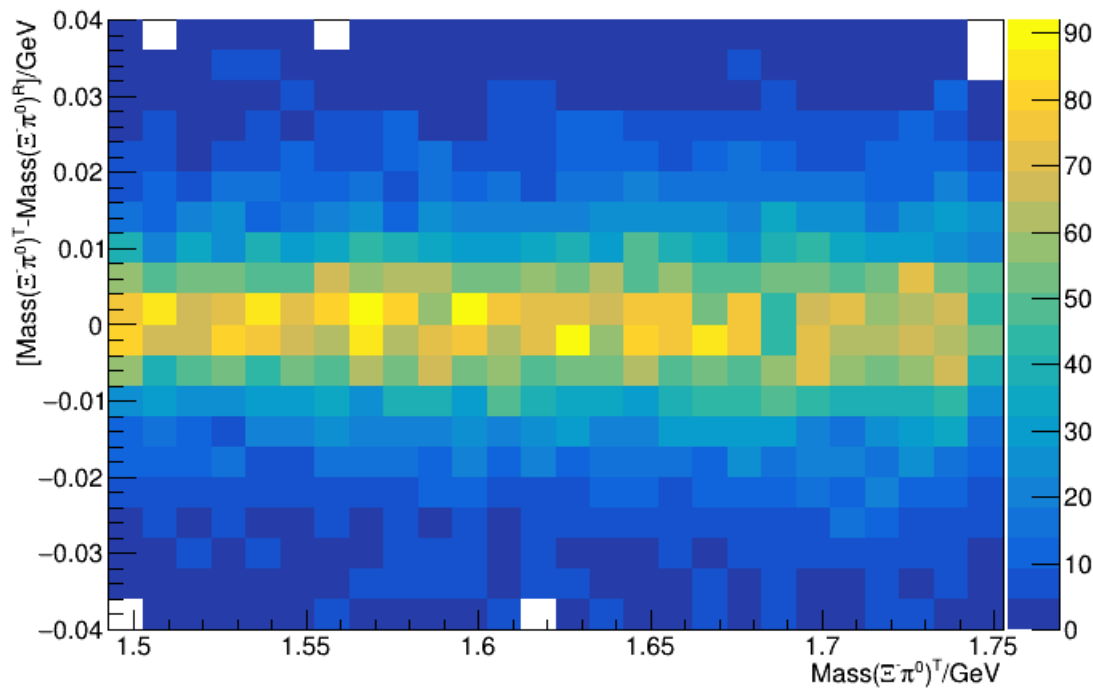
Ignoring for now: Will deal with $\Xi(1530)$ shape problem at a later date

Monte Carlo: Resolution of mass [$E^- \pi^0$]

- [Mass True – Mass Reconstructed] versus Mass True

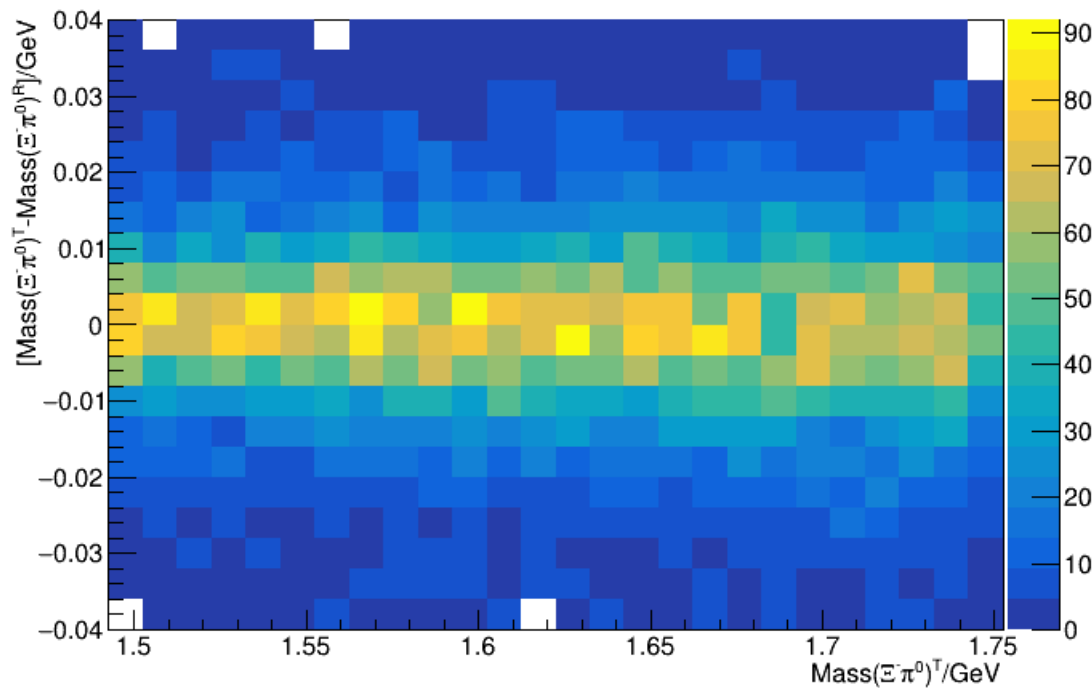
Monte Carlo: Resolution of mass [$E^- \pi^0$]

- [Mass True – Mass Reconstructed] versus Mass True

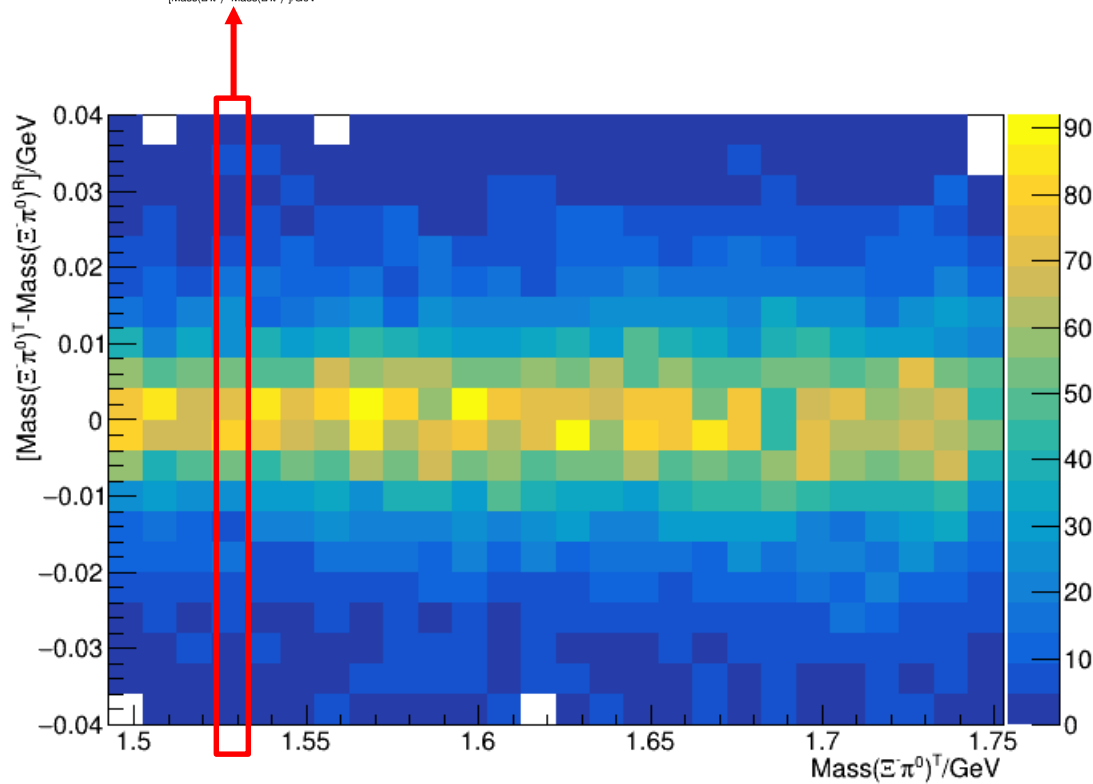
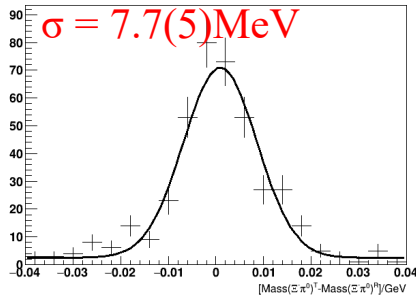


Monte Carlo: Resolution of mass [$\Xi^-\pi^0$]

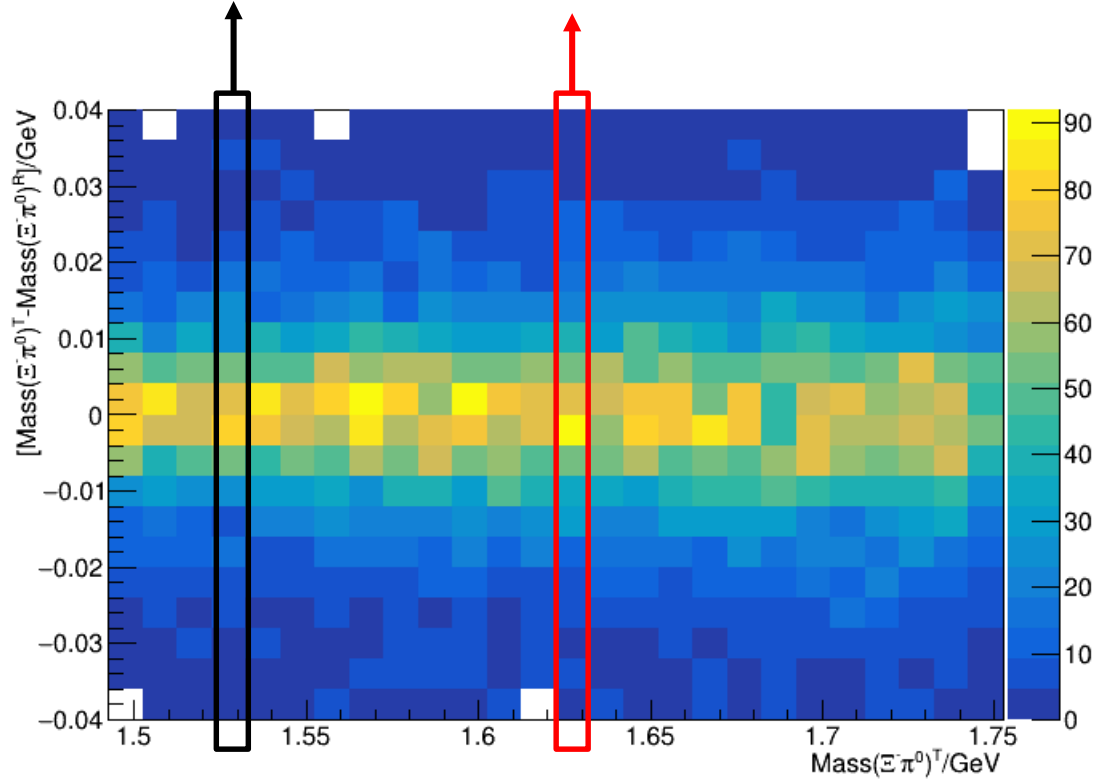
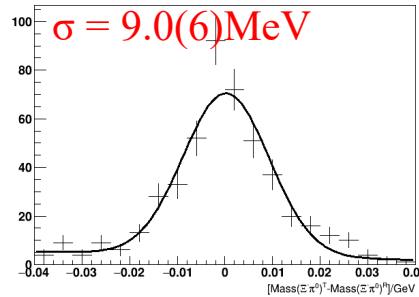
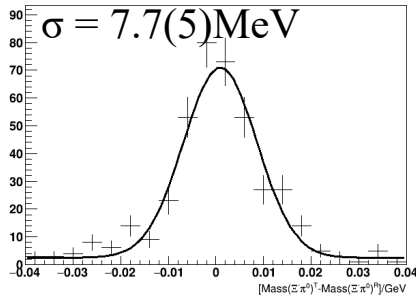
- [Mass True – Mass Reconstructed] versus Mass True
- Will zoom in on masses near the $\Xi(1530)$, $\Xi(1620)$ and $\Xi(1690)$



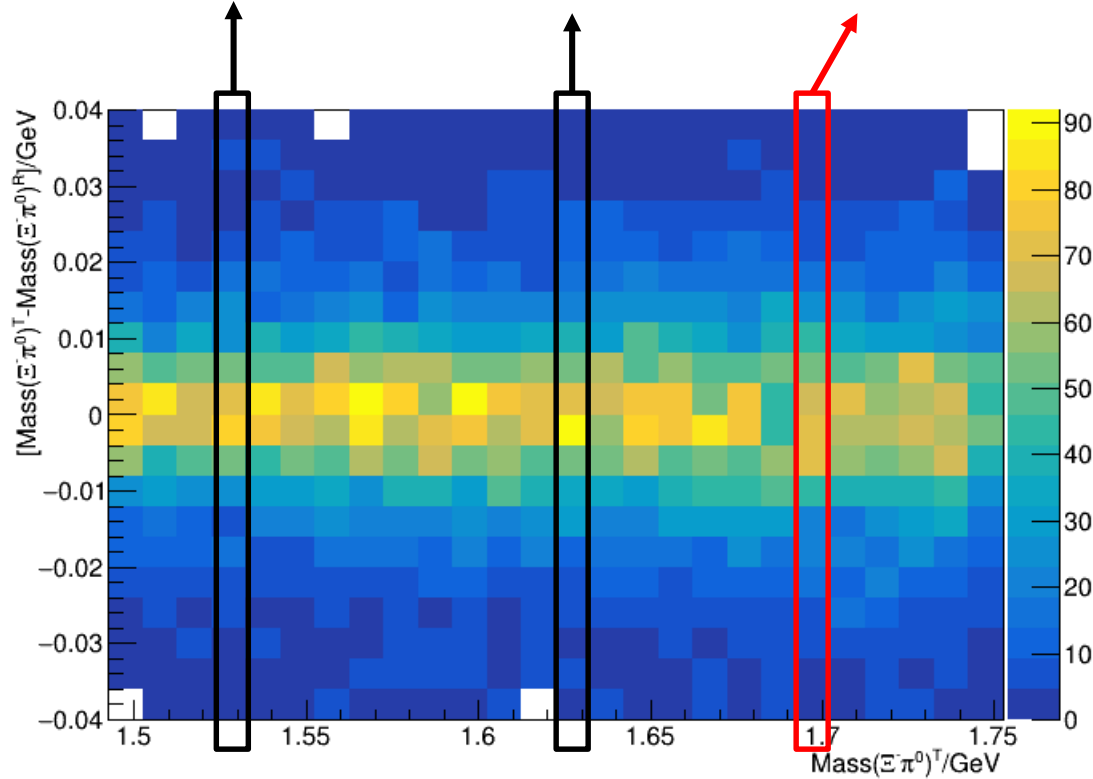
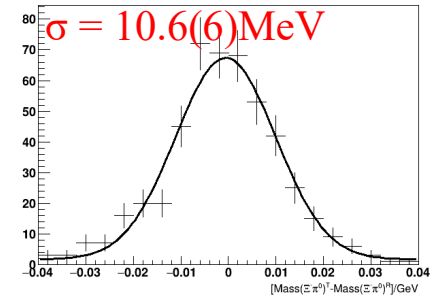
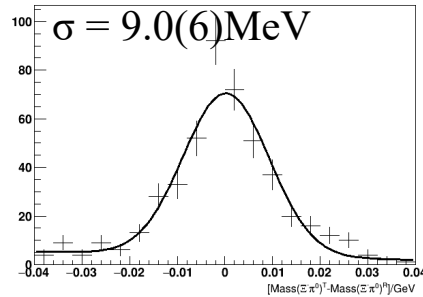
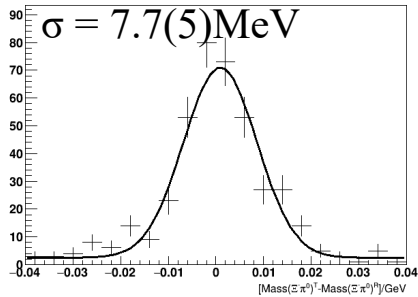
Monte Carlo: Resolution of mass [$E^- \pi^0$]



Monte Carlo: Resolution of mass [$E^- \pi^0$]



Monte Carlo: Resolution of mass [$E^-\pi^0$]



Fits to $E(1530)$, $E(1620)$ and $E(1690)$

The fit:

- Background: 2nd order polynomial multiplied by sigmoid

Fits to $E(1530)$, $E(1620)$ and $E(1690)$

The fit:

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- Three E^* , each represented by a Voight function with appropriate smearing parameter σ (as determined in prior slide)

Fits to $\mathcal{E}(1530)$, $\mathcal{E}(1620)$ and $\mathcal{E}(1690)$

The fit:

- Background: 2nd order polynomial multiplied by sigmoid
- Three \mathcal{E}^* , each represented by a Voigt function with appropriate smearing parameter σ (as determined in prior slide)

Note on what will be shown:

- The $\mathcal{E}(1530)$ that will be shown have no serious issues

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- The $\mathcal{E}(1620)$ that will be shown might be real (but might not ☹)

Fits to $\Xi(1530)$, $\Xi(1620)$ and $\Xi(1690)$

The fit:

- Background: 2nd order polynomial multiplied by sigmoid
- Three Ξ^* , each represented by a Voigt function with appropriate smearing parameter σ (as determined in prior slide)

Note on what will be shown:

- The $\Xi(1530)$ that will be shown have no serious issues
- The $\Xi(1620)$ that will be shown might be real (but might not ☹)
- The $\Xi(1690)$ that will be shown all have zero width and are probably a statistical fluctuation. The line shapes (**cyan**) will be entirely due to the resolution of the reconstructed mass($\Xi\text{-}\pi^0$)

Fits to $E(1530)$, $E(1620)$ and $E(1690)$

Cuts on GlueX data:

Fits to $\Xi(1530)$, $\Xi(1620)$ and $\Xi(1690)$

Cuts on GlueX data:

- Using best σ_Y/Y :
 - $CL > 10^{-6}$
 - Ξ track-length significance > 4

Fits to $E(1530)$, $E(1620)$ and $E(1690)$

Cuts on GlueX data:

- Using best σ_Y/Y :
 - $CL > 10^{-6}$
 - E track-length significance > 4
- E^- cut:
 - Kept event when
 $1.30 < \text{mass}[\Lambda\pi]/\text{GeV} < 1.35$

Fits to $\Xi(1530)$, $\Xi(1620)$ and $\Xi(1690)$

Cuts on GlueX data:

- Using best $\sigma_{Y'}/Y$:
 - $CL > 10^{-6}$
 - Ξ track-length significance > 4
- Ξ^- cut:
 - Kept event when
 $1.30 < \text{mass}[\Lambda\pi]/\text{GeV} < 1.35$
- K^* cut:
 - Remove event when
 $0.85 < \text{mass}[K^+\pi^0]/\text{GeV} < 0.95$

Fits to $\Xi(1530)$, $\Xi(1620)$ and $\Xi(1690)$

Cuts on GlueX data:

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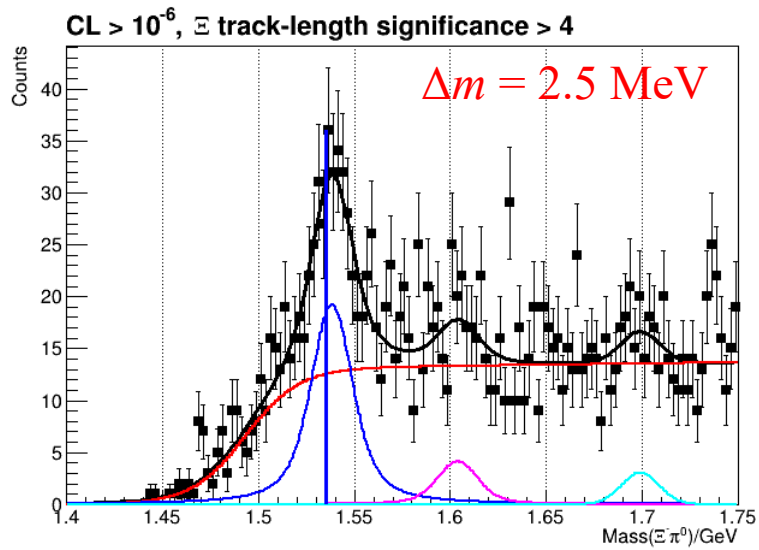
Other:

- Explored various mass binning

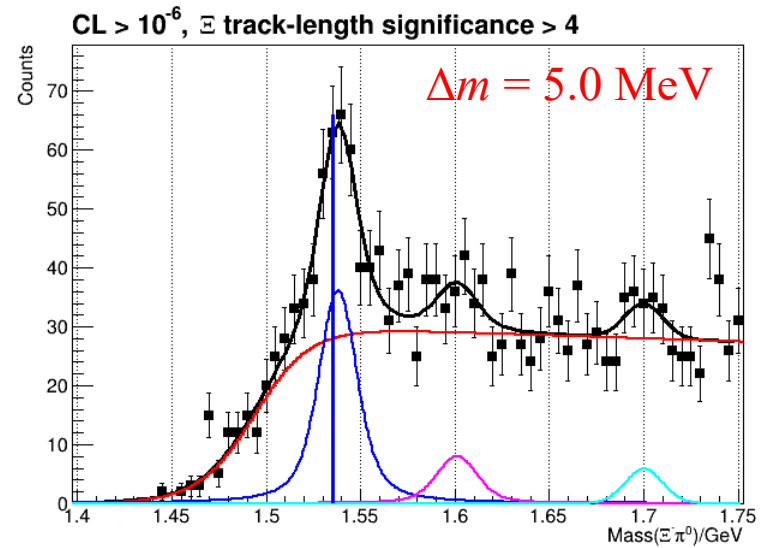
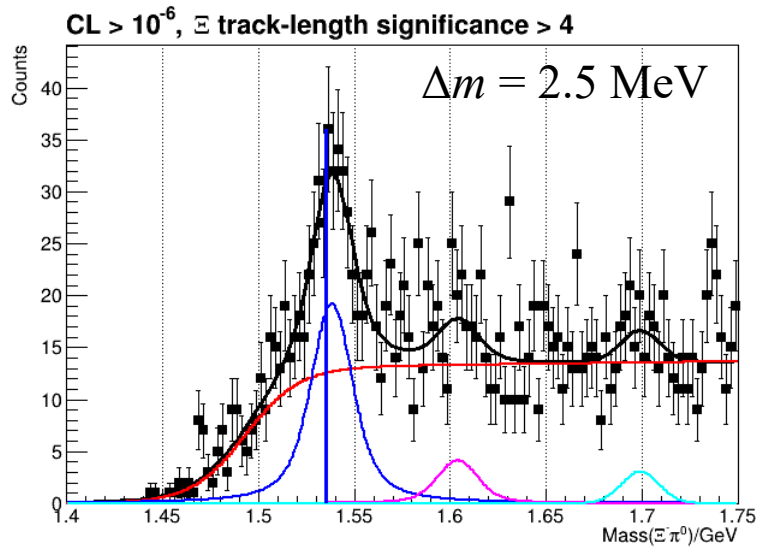


Mass binning

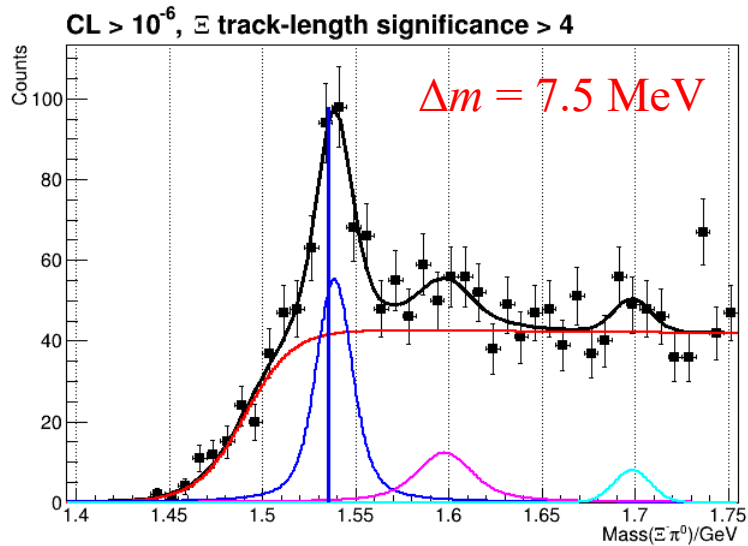
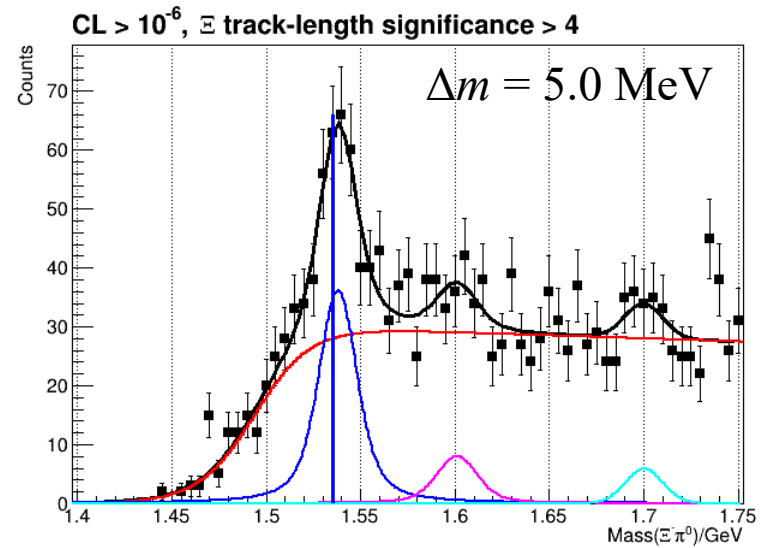
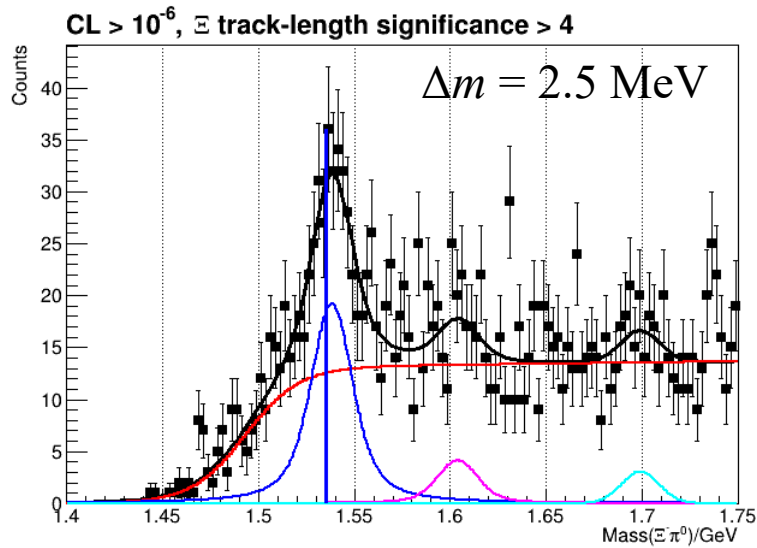
Mass binning



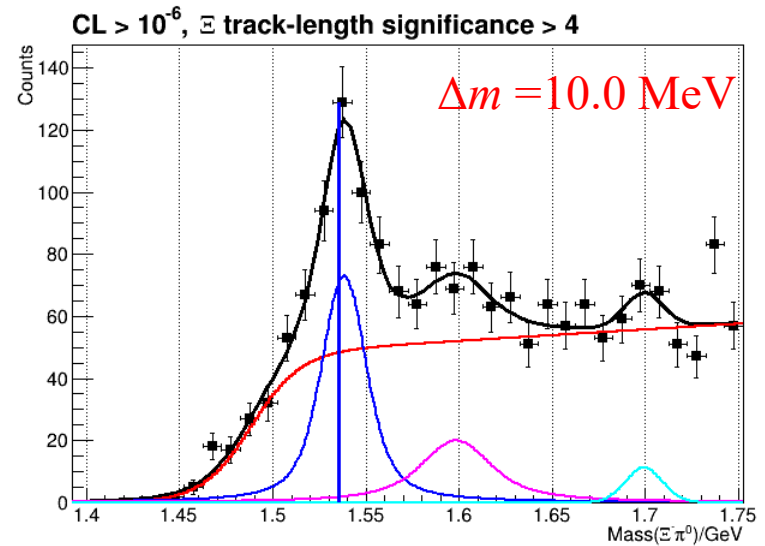
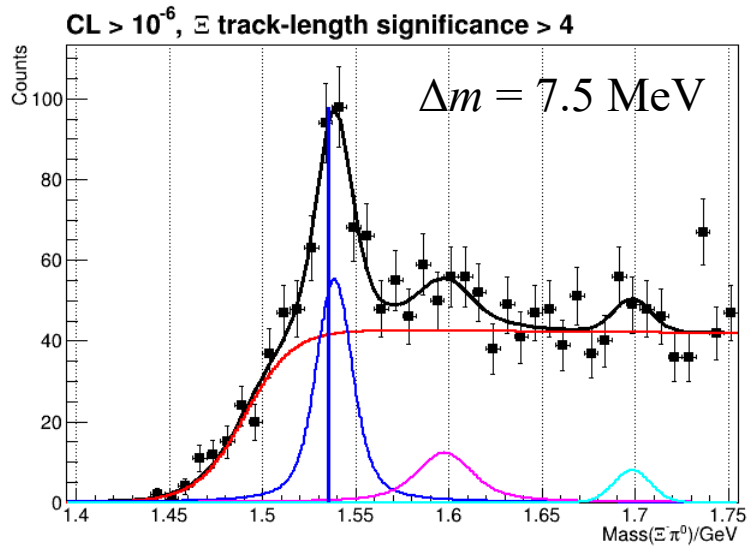
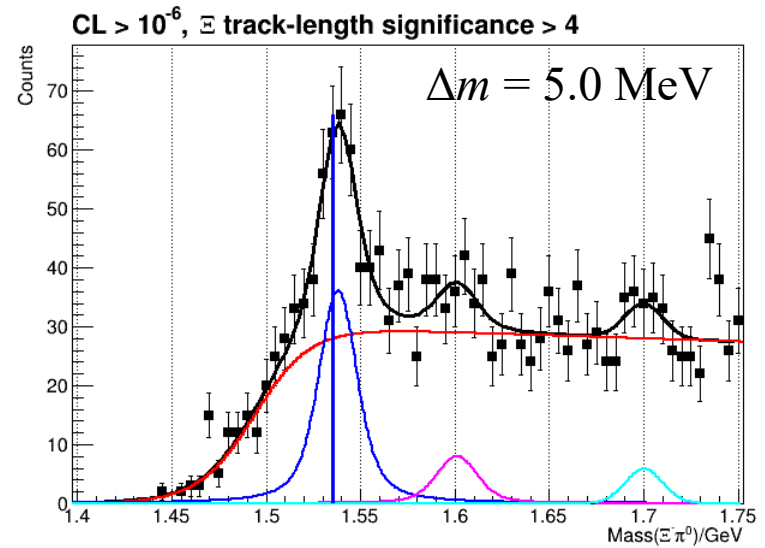
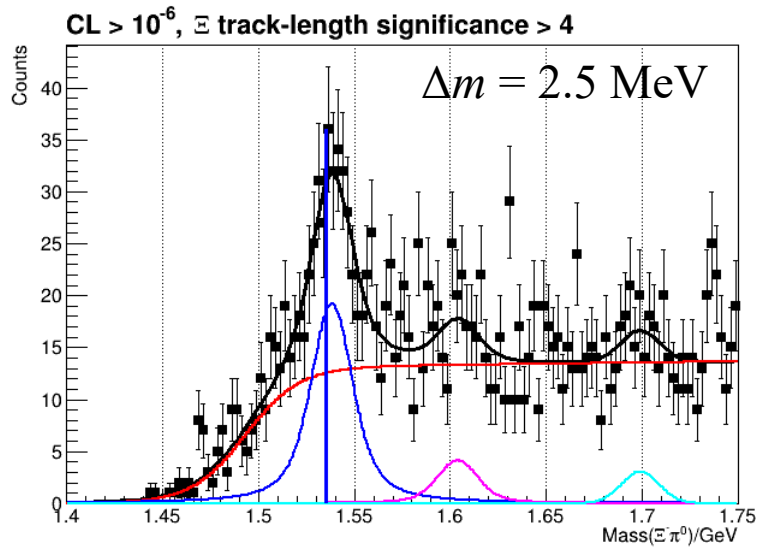
Mass binning



Mass binning



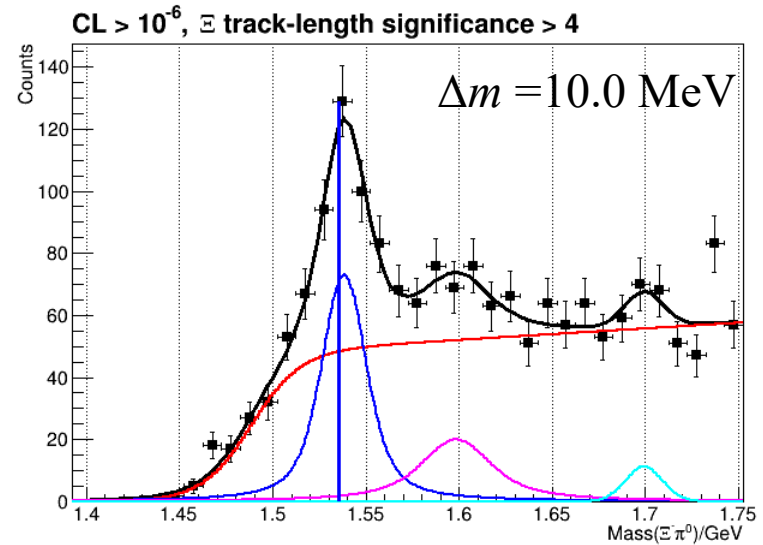
Mass binning



Fit results

$E(1530)$:

- Center = 1538(2) MeV [PDG: 1535.2 +/- 0.8 MeV]
- Width = 16(10) MeV [PDG: $9.9^{+1.7}_{-1.9}$ MeV]



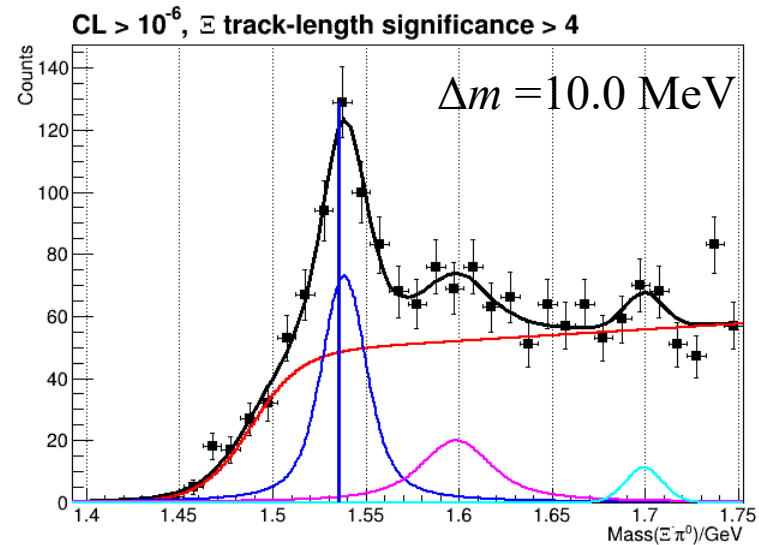
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$E(1620)$:

- Center = 1598(8) MeV
- Width = 34(37) MeV



Fit results

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- Center = 1538(2) MeV [PDG: 1535.2 +/- 0.8 MeV]
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$\Xi(1620)$:

- Center = 1598(8) MeV
- Width = 34(37) MeV

$\Xi(1620)$

$I(J^P) = \frac{1}{2}(??)$ 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 HAS-SALL 81) have looked for the state but have not seen any effect.

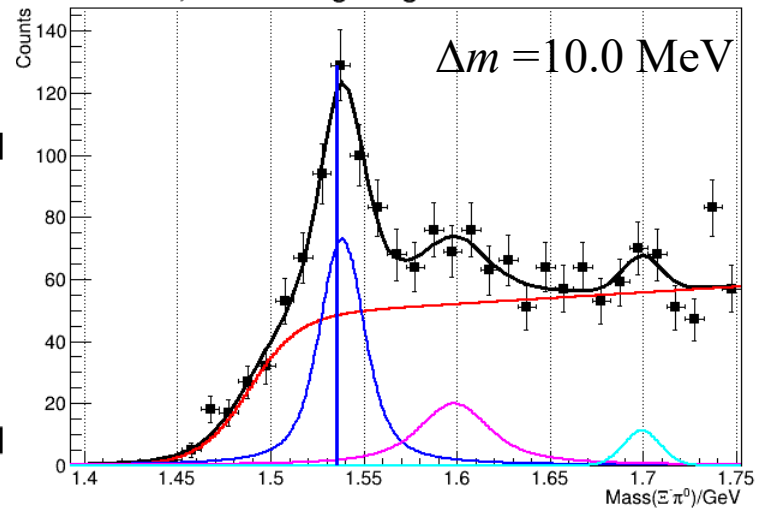
$\Xi(1620)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
1620 OUR ESTIMATE				
$1610.4 \pm 6.0_{-4.2}^{+6.1}$		SUMIHAMA	19	BELL $\Xi_c^+ \rightarrow \Xi(1620)\pi^+$
1624 ± 3	31	BRIEFEL	77	HBC $K^- p$ 2.87 GeV/c
1633 ± 12	34	DEBELLEFON	75B	HBC $K^- p \rightarrow \Xi^- \bar{K} \pi$
1606 ± 6	29	ROSS	72	HBC $K^- p$ 3.1-3.7 GeV/c

$\Xi(1620)$ WIDTH

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
32 ± 8 OUR AVERAGE				Error includes scale factor of 2.2. See the ideogram below.
$59.9 \pm 4.8_{-7.1}^{+2.8}$		SUMIHAMA	19	BELL $\Xi_c^+ \rightarrow \Xi(1620)\pi^+$
22.5 ± 7.5	31	¹ BRIEFEL	77	HBC $K^- p$ 2.87 GeV/c
40 ± 15	34	DEBELLEFON	75B	HBC $K^- p \rightarrow \Xi^- \bar{K} \pi$
21 ± 7	29	ROSS	72	HBC $K^- p \rightarrow \Xi^- \pi^+ K^*0(892)$

CL > 10⁻⁶, Ξ track-length significance > 4



Fit results

$\Xi(1530)$:

- Center = 1538(2) MeV [PDG: 1535.2 +/- 0.8 MeV]
- Width = 16(10) MeV [PDG: $9.9_{-1.9}^{+1.7}$ MeV]

$\Xi(1620)$:

- Center = 1598(8) MeV
- Width = 34(37) MeV

$\Xi(1620)$

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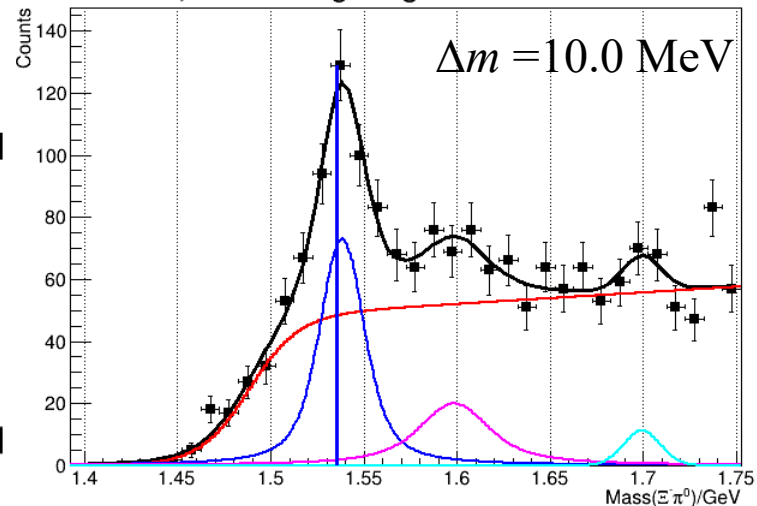
$\Xi(1620)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
≈ 1620 OUR ESTIMATE				
$1610.4 \pm 6.0_{-4.2}^{+6.1}$		SUMIHAMA 19	BELL	$\Xi_c^+ \rightarrow \Xi(1620)\pi^+$
1624 ± 3	31	BRIEFEL 77	HBC	$K^- p$ 2.87 GeV/c
1633 ± 12	34	DEBELLEFON 75B	HBC	$K^- p \rightarrow \Xi^- \bar{K} \pi$
1606 ± 6	29	ROSS 72	HBC	$K^- p$ 3.1-3.7 GeV/c

$\Xi(1620)$ WIDTH

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
32 ± 8 OUR AVERAGE				Error includes scale factor of 2.2. See the ideogram below.
$59.9 \pm 4.8_{-7.1}^{+2.8}$		SUMIHAMA 19	BELL	$\Xi_c^+ \rightarrow \Xi(1620)\pi^+$
22.5 ± 7.5	31	BRIEFEL 77	HBC	$K^- p$ 2.87 GeV/c
40 ± 15	34	DEBELLEFON 75B	HBC	$K^- p \rightarrow \Xi^- \bar{K} \pi$
21 ± 7	29	ROSS 72	HBC	$K^- p \rightarrow \Xi^- \pi^+ K^*(892)$

CL > 10⁻⁶, Ξ track-length significance > 4



Fit results

$\Xi(1530)$:

- Center = 1538(2) MeV [PDG: 1535.2 +/- 0.8 MeV]
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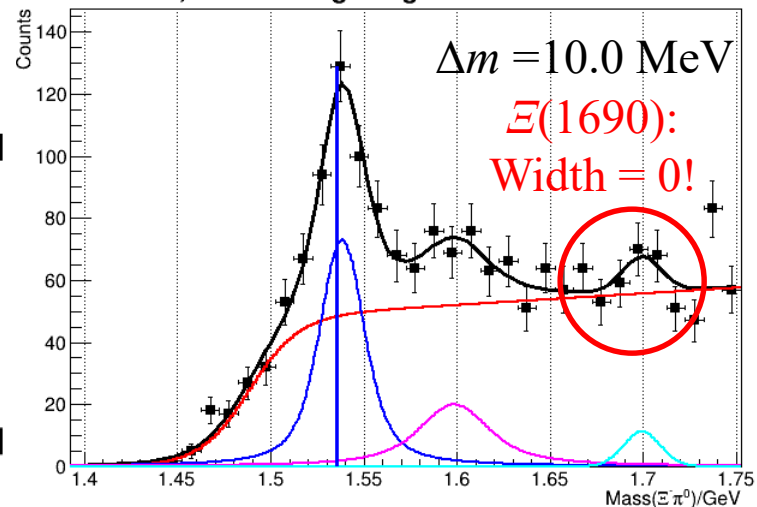
$\Xi(1620)$ MASS

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
≈ 1620 OUR ESTIMATE				
$1610.4 \pm 6.0_{-4.2}^{+6.1}$		SUMIHAMA 19	BELL	$\Xi_c^+ \rightarrow \Xi(1620)\pi^+$
1624 ± 3	31	BRIEFEL 77	HBC	$K^- p$ 2.87 GeV/c
1633 ± 12	34	DEBELLEFON 75B	HBC	$K^- p \rightarrow \Xi^- \bar{K} \pi$
1606 ± 6	29	ROSS 72	HBC	$K^- p$ 3.1-3.7 GeV/c

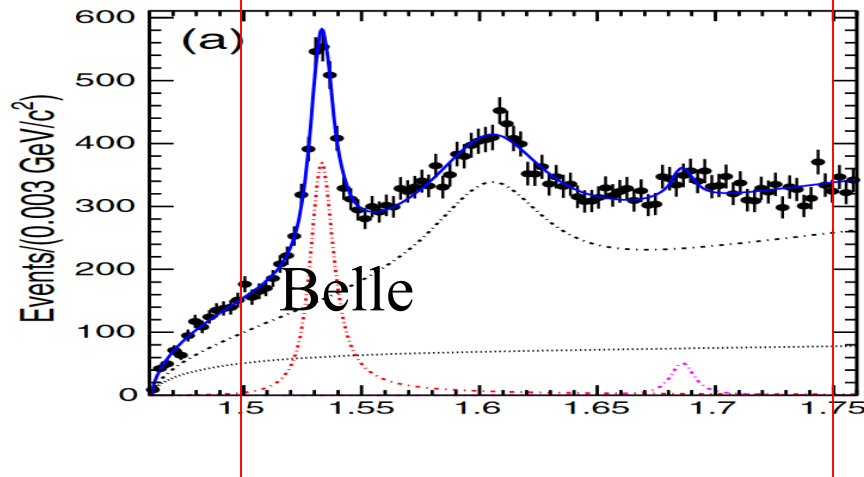
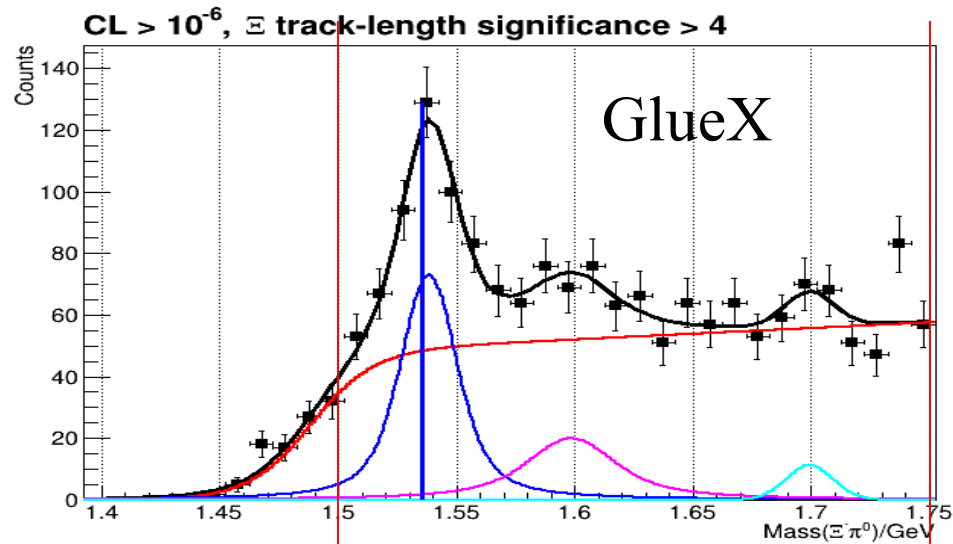
$\Xi(1620)$ WIDTH

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
$32 \pm 8_{-9}$ OUR AVERAGE				Error includes scale factor of 2.2. See the ideogram below.
$59.9 \pm 4.8_{-7.1}^{+2.8}$		SUMIHAMA 19	BELL	$\Xi_c^+ \rightarrow \Xi(1620)\pi^+$
22.5 ± 7.5	31	¹ BRIEFEL 77	HBC	$K^- p$ 2.87 GeV/c
40 ± 15	34	DEBELLEFON 75B	HBC	$K^- p \rightarrow \Xi^- \bar{K} \pi$
21 ± 7	29	ROSS 72	HBC	$K^- p \rightarrow \Xi^- \pi^+ K^*0(892)$

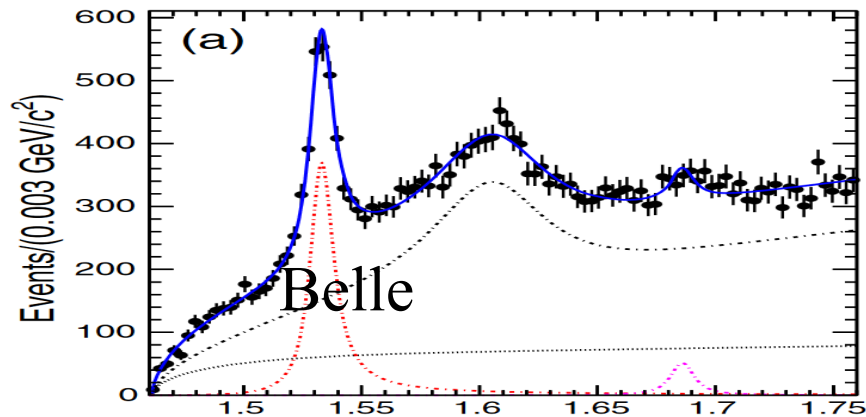
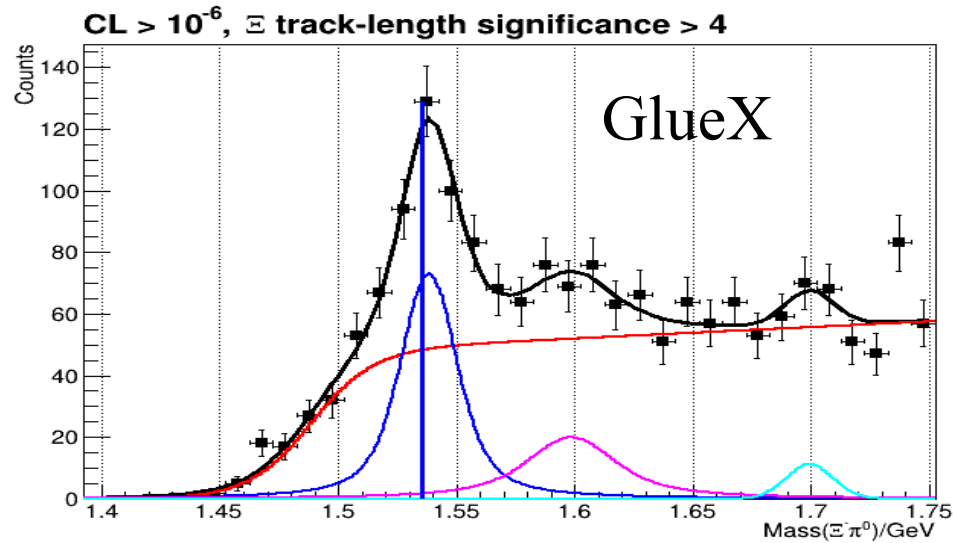
CL > 10⁻⁶, Ξ track-length significance > 4



Comparison to Belle

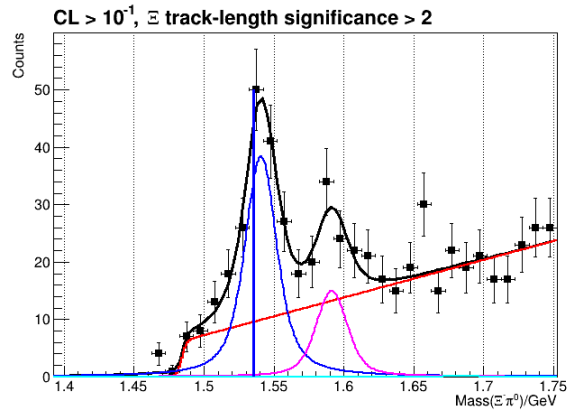
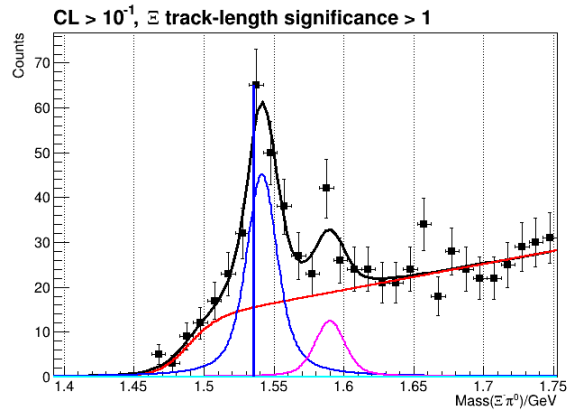


Comparison to Belle

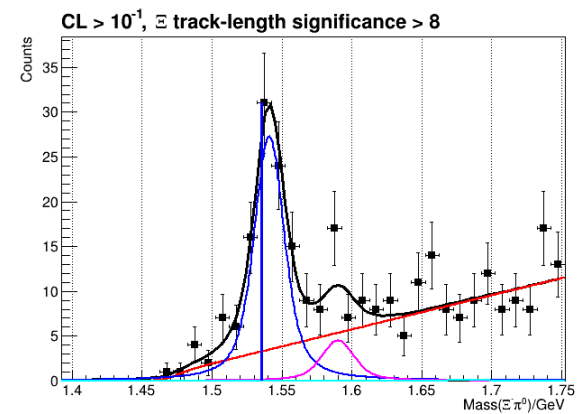
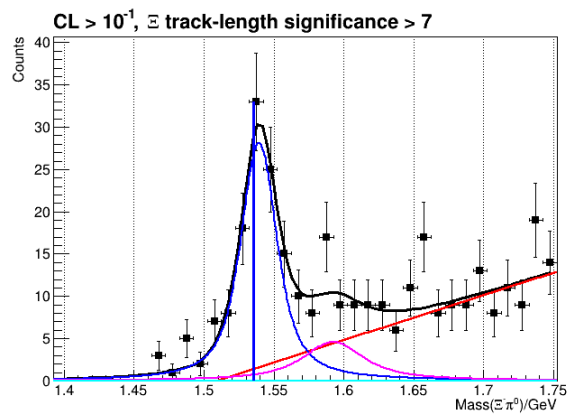
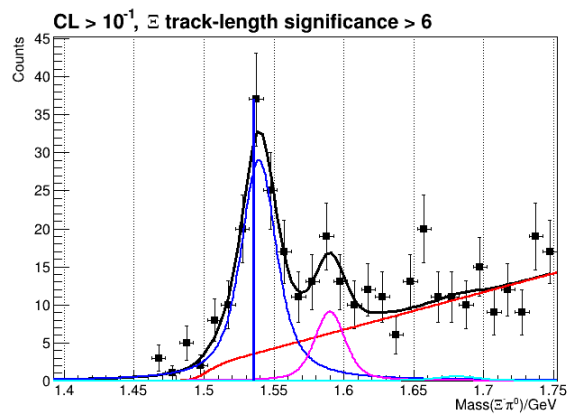
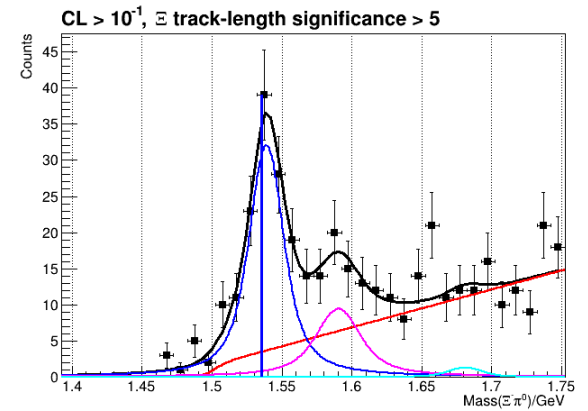
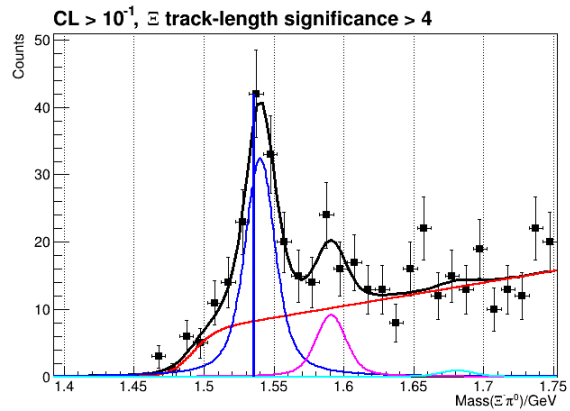
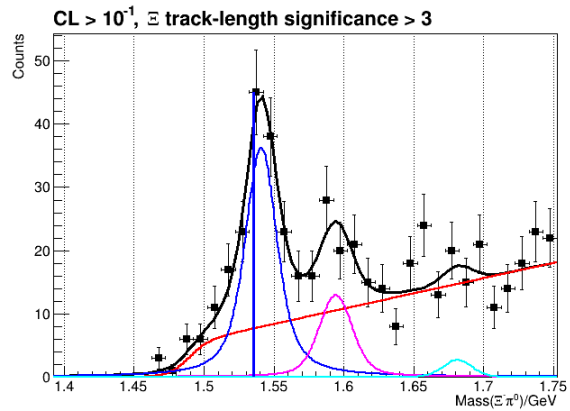


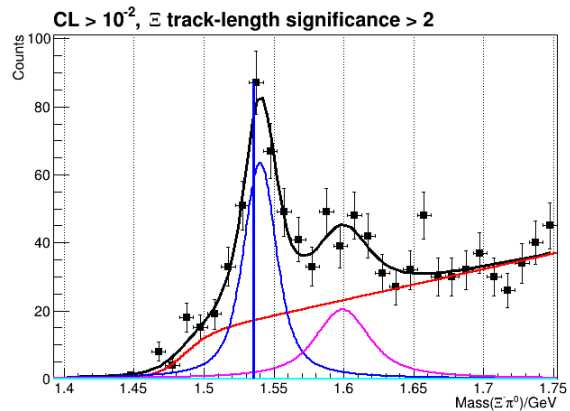
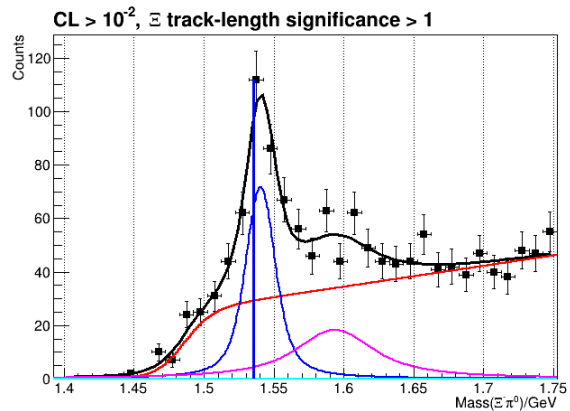
The other fits

I have put all of the other fits (each CL and track-length significance) on the following slides

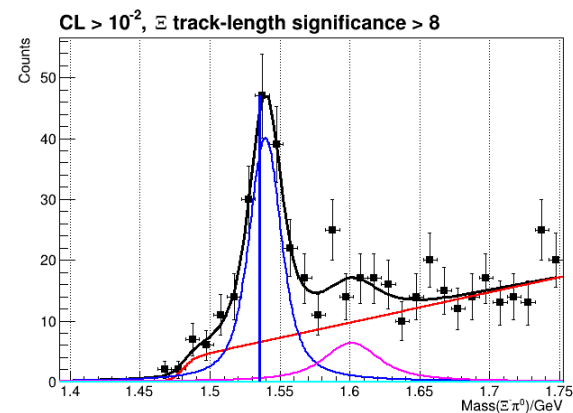
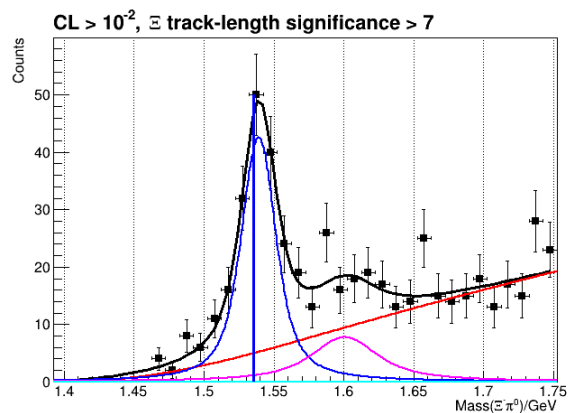
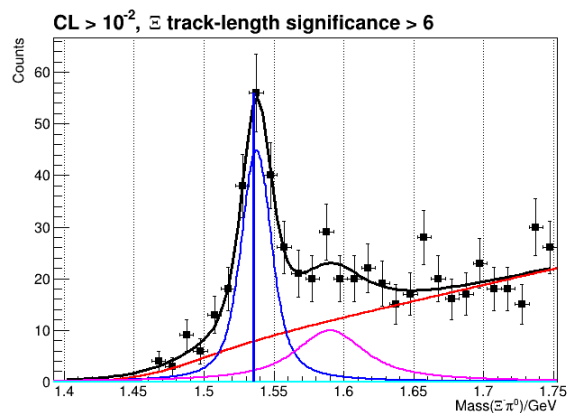
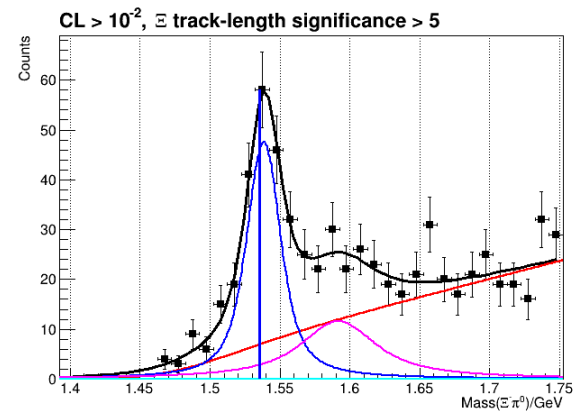
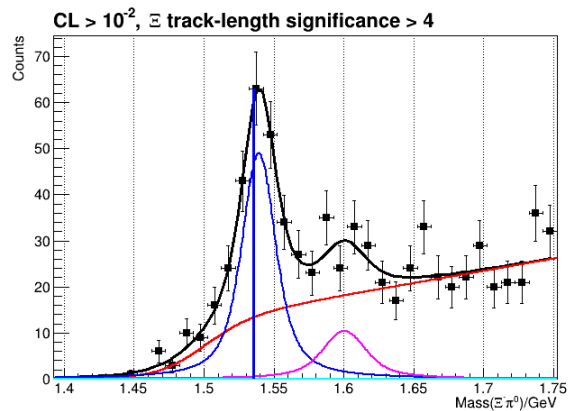
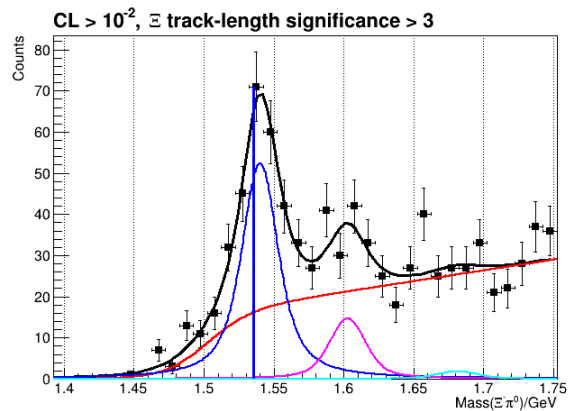


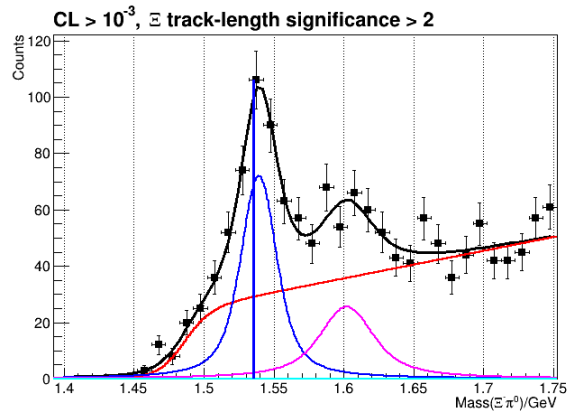
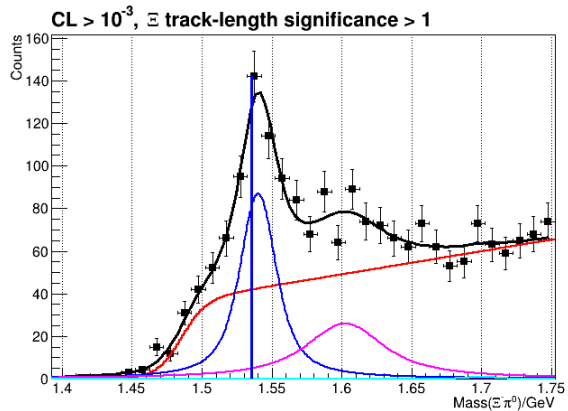
CL > 10⁻¹



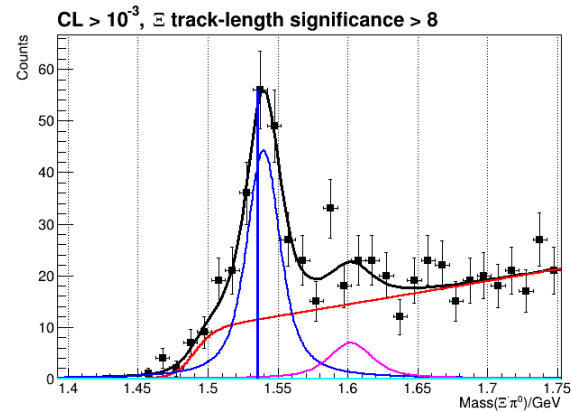
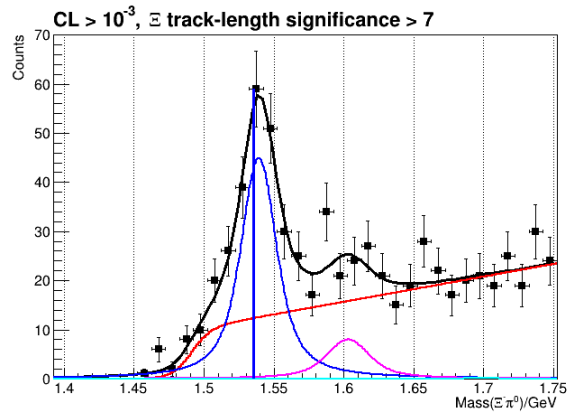
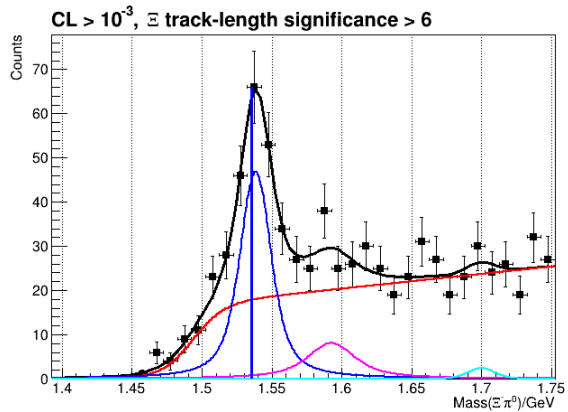
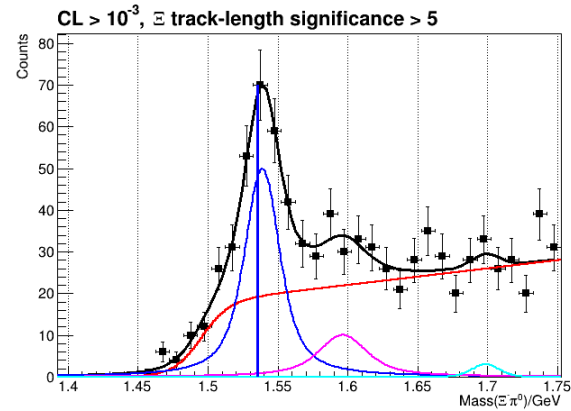
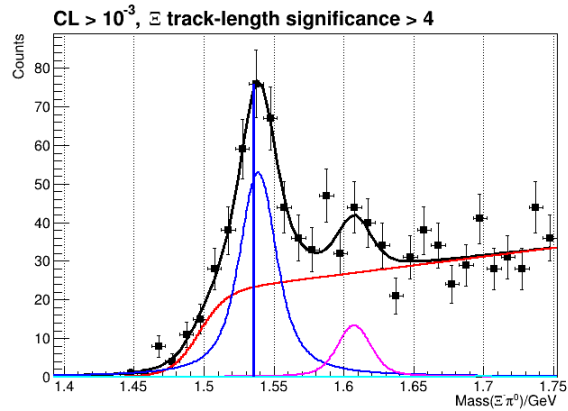
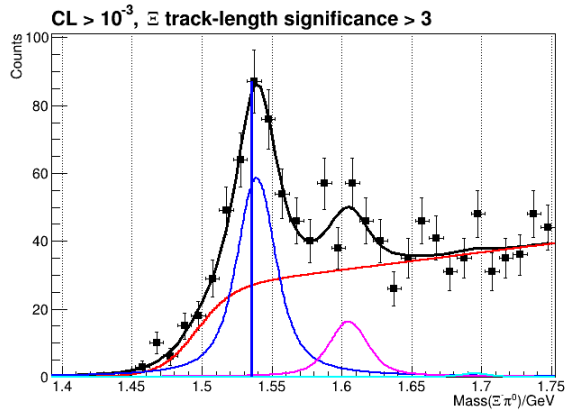


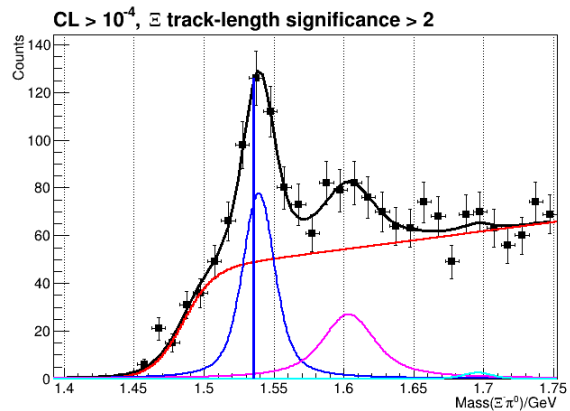
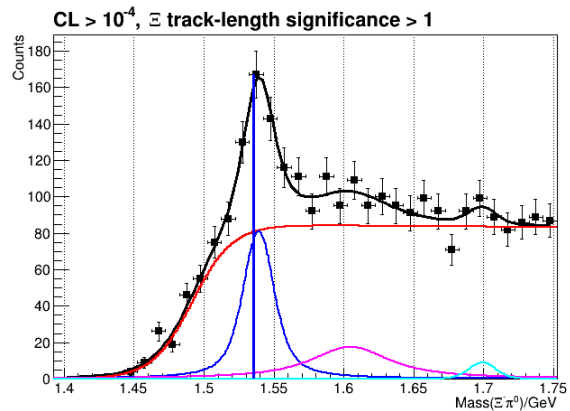
CL > 10⁻²



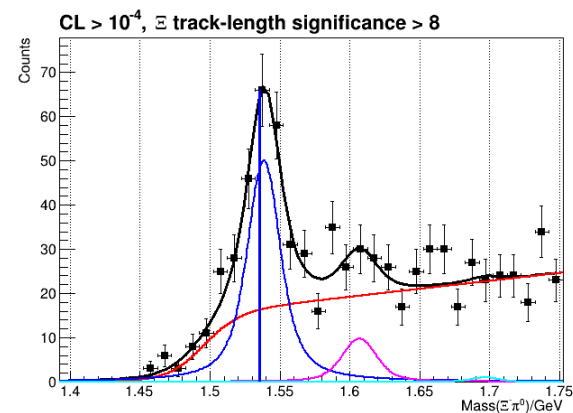
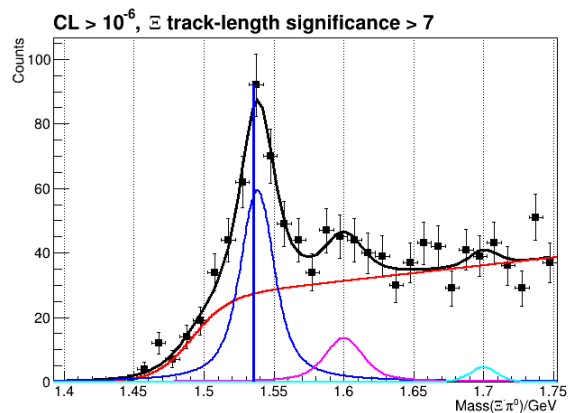
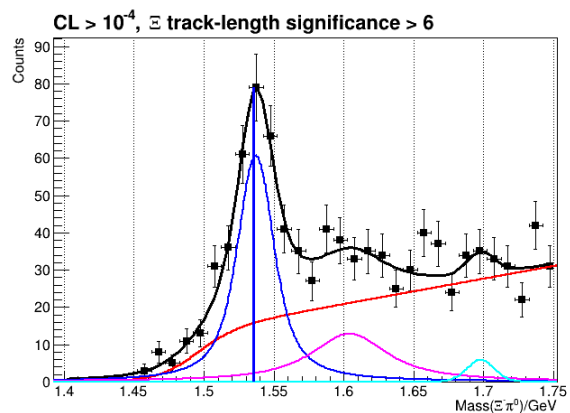
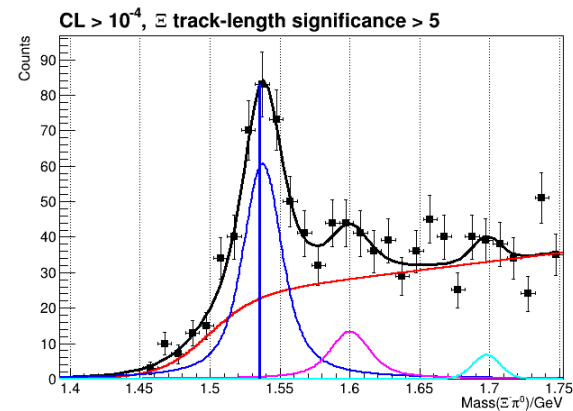
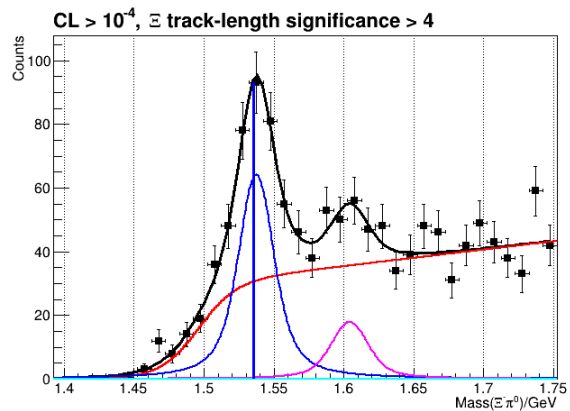
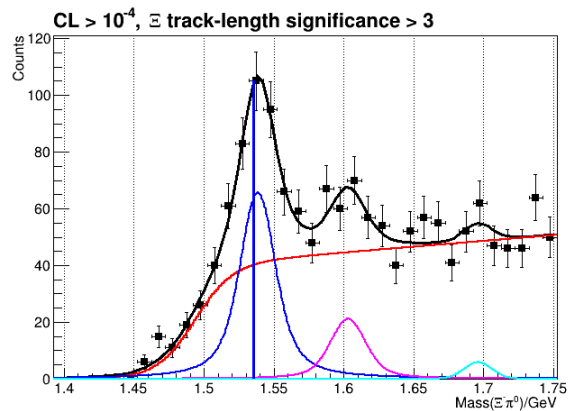


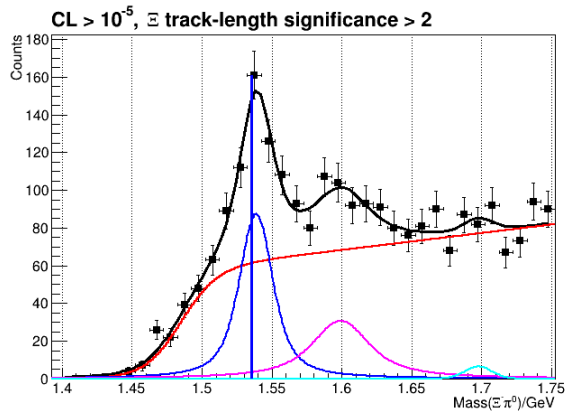
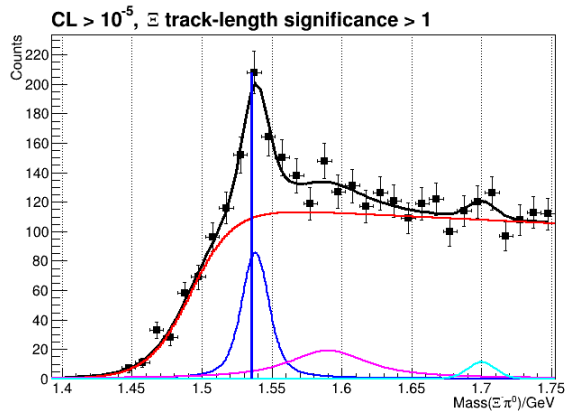
CL > 10⁻³



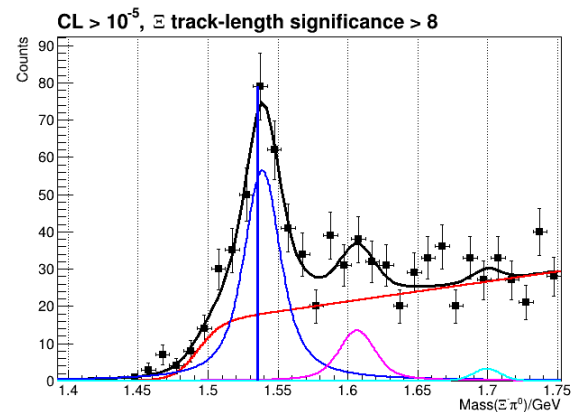
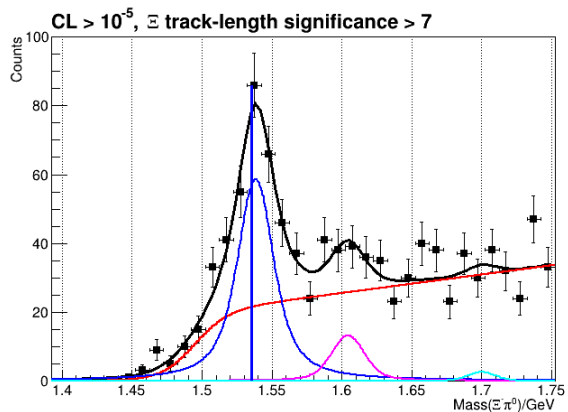
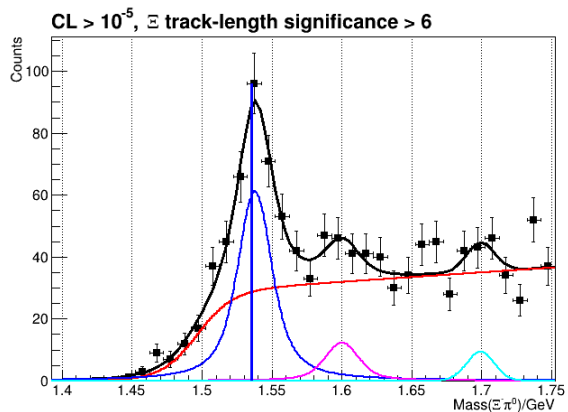
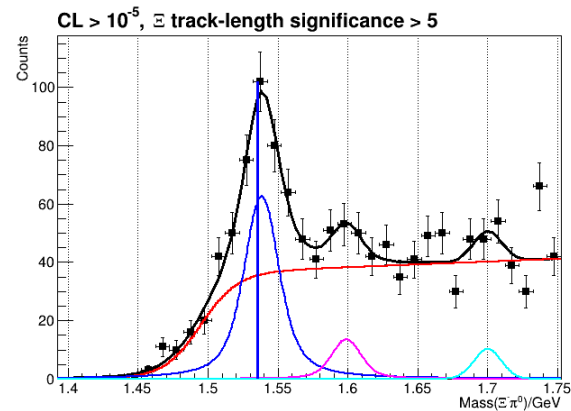
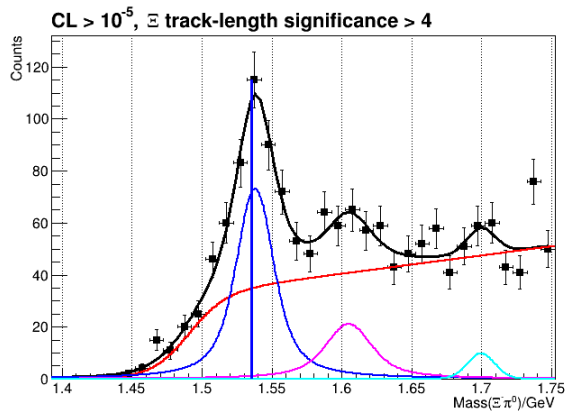
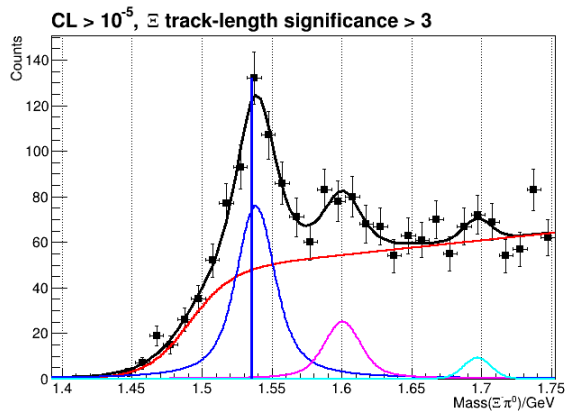


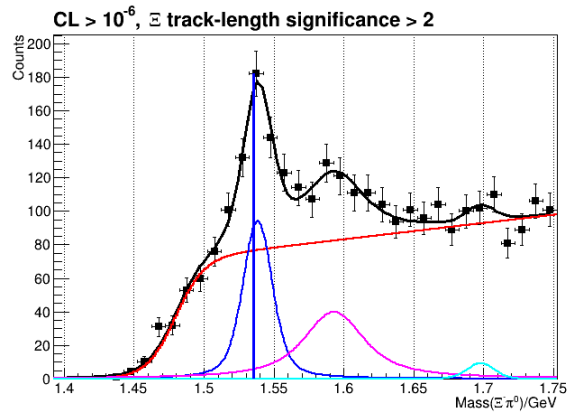
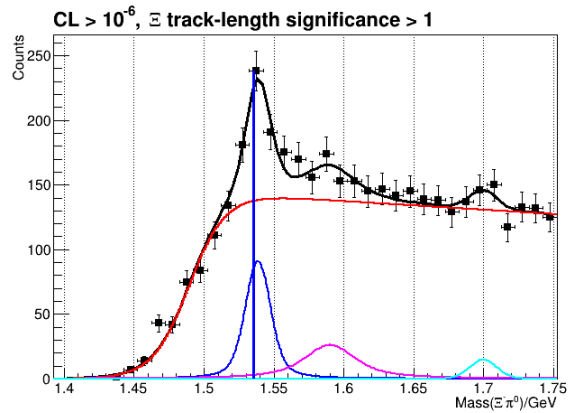
CL > 10⁻⁴



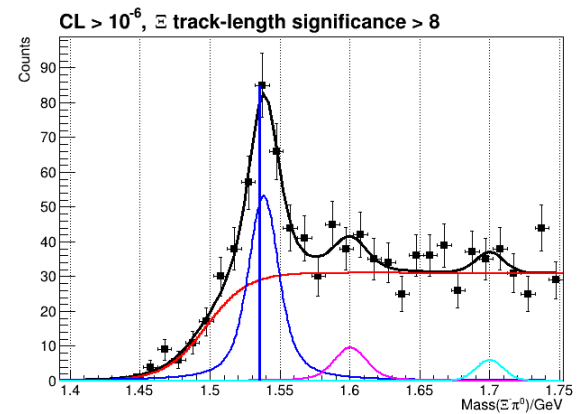
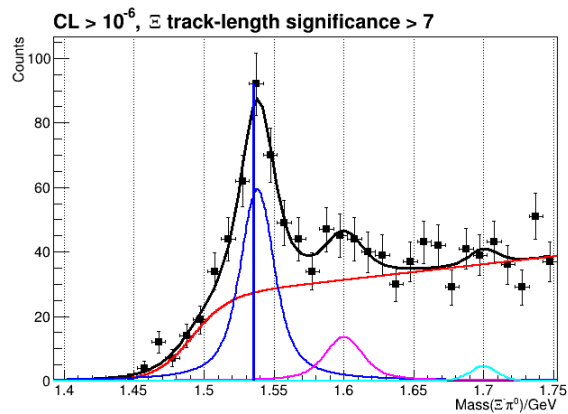
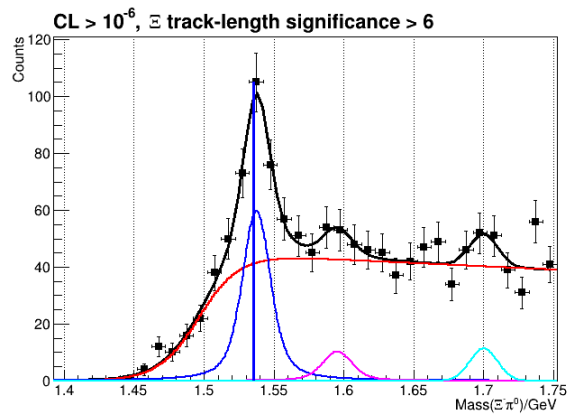
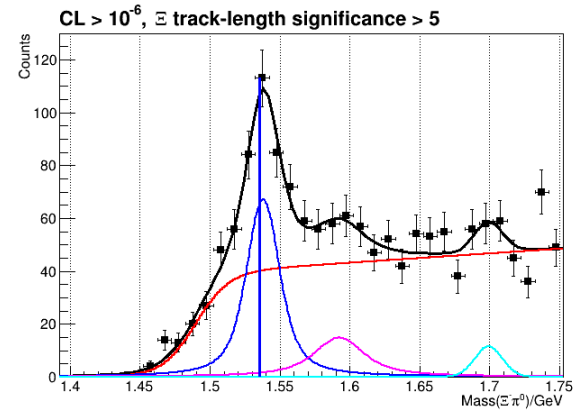
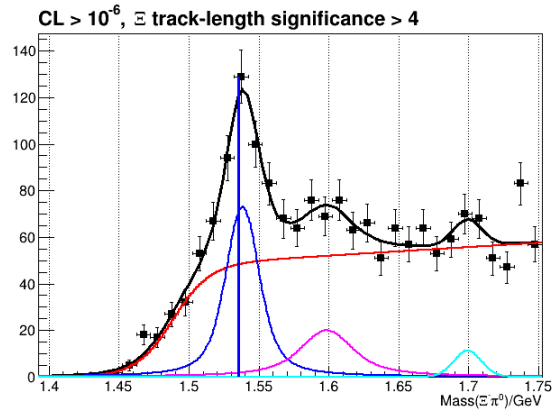
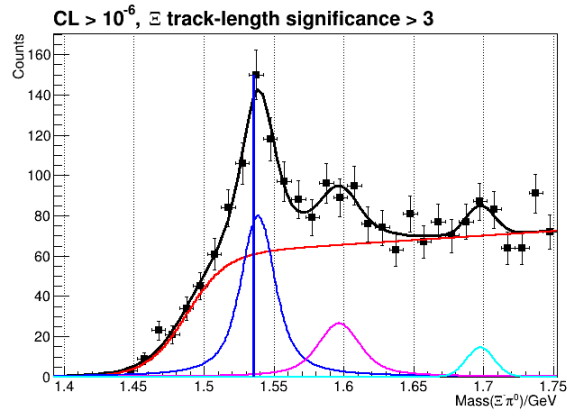


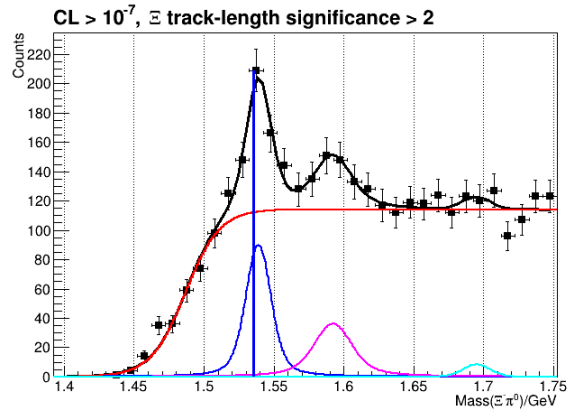
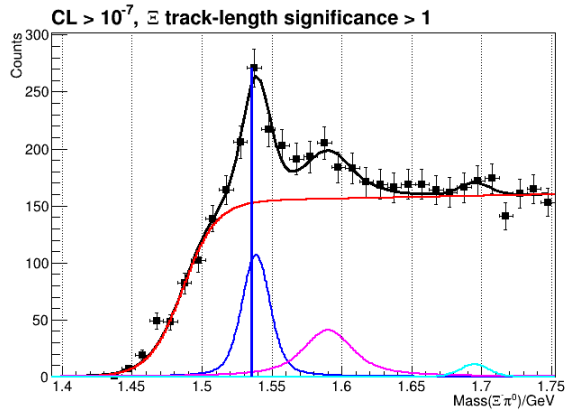
CL > 10⁻⁵



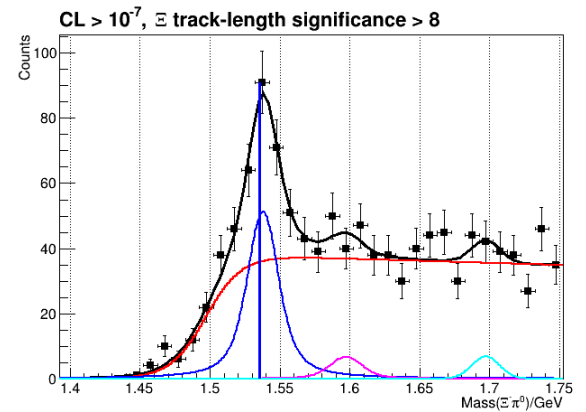
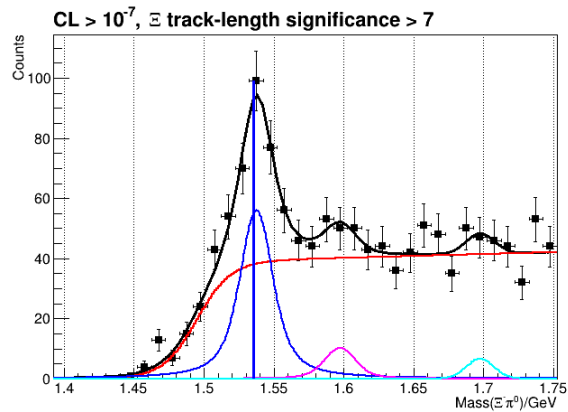
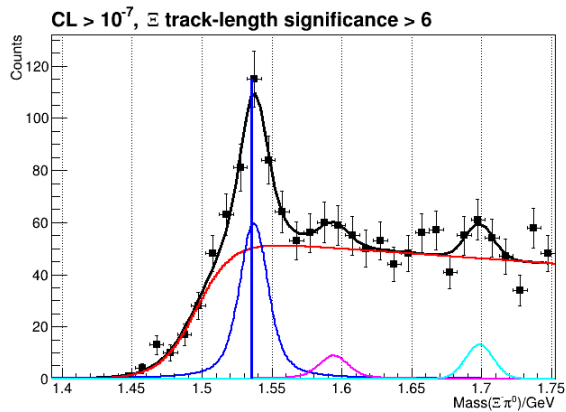
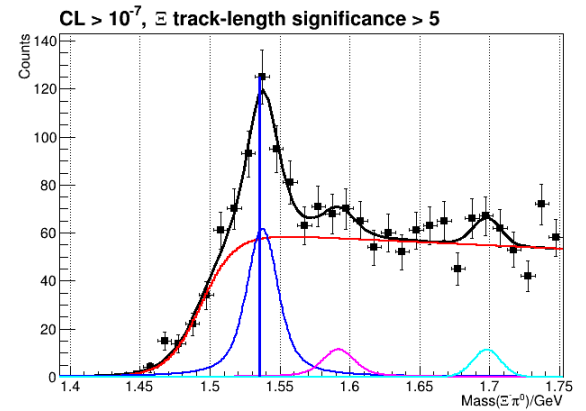
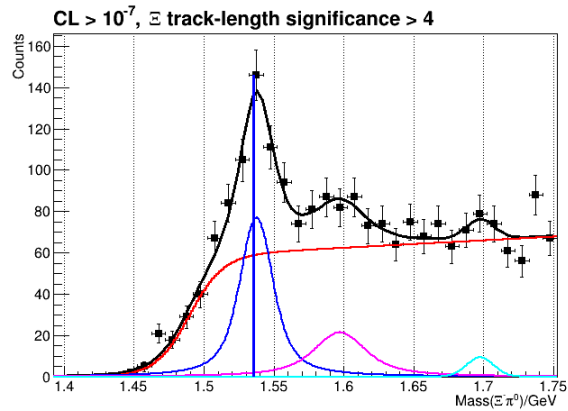
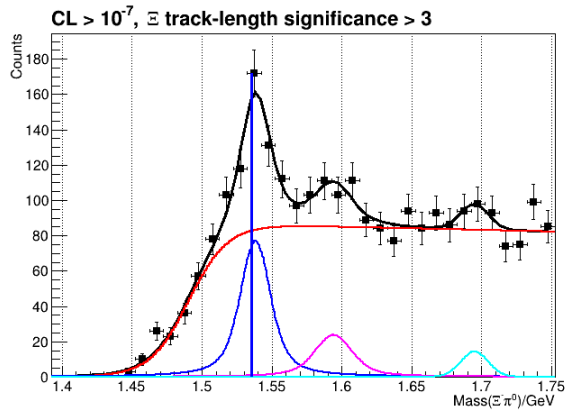


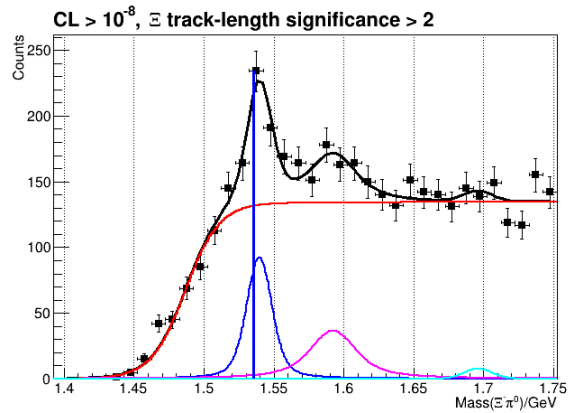
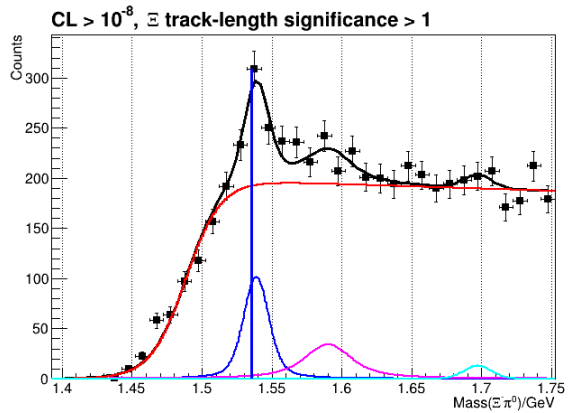
CL > 10⁻⁶



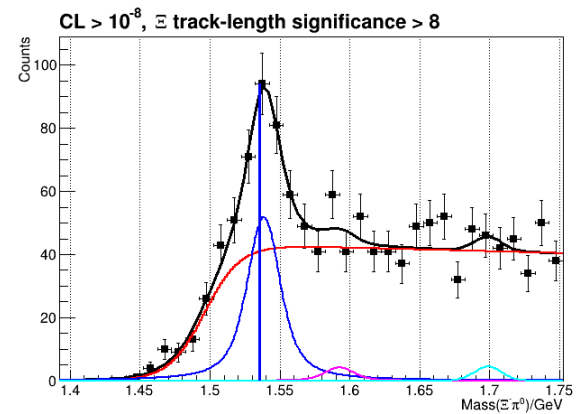
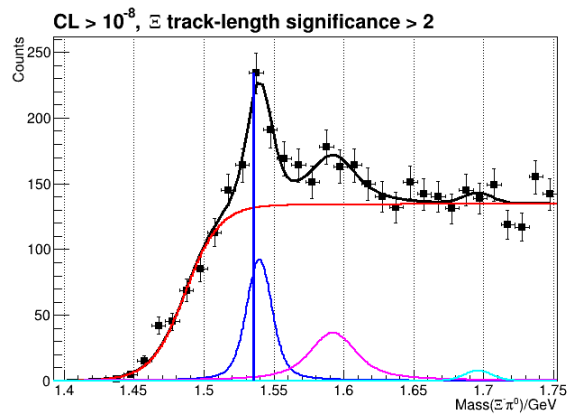
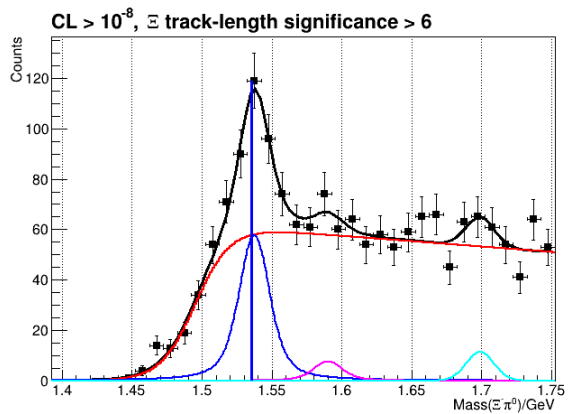
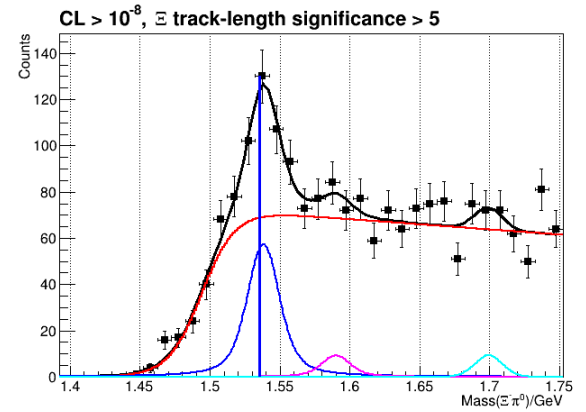
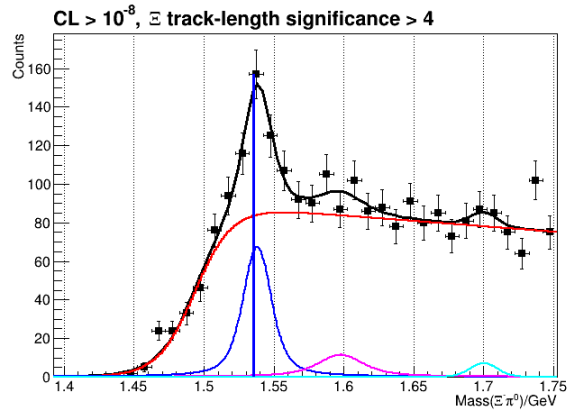
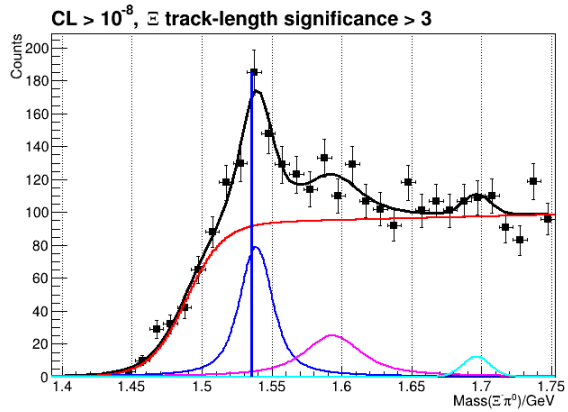


CL > 10⁻⁷





CL > 10⁻⁸



Title

