Simulation of $\gamma\, p \rightarrow K^{+}K^{+}\Xi^{-}(1530)$

Reaction

$$\gamma\, p \rightarrow K^{+} K^{+} \Xi^{-}(1530),$$

Reaction

$$\gamma\, p \rightarrow K^{+}K^{+}\Xi^{-}(1530),$$

where $\Xi^{-}(1530) \rightarrow \Xi^{-}\pi^{0},$

Reaction

$$\gamma\, p \rightarrow K^{+} K^{+} \Xi^{-}(1530),$$

where $\Xi^{-}(1530) \rightarrow \Xi^{-}\pi^{0},$

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

Reaction

$$\gamma\, p \rightarrow K^+ K^+ \Xi^- (1530),$$

where $\Xi^-(1530) \rightarrow \Xi^- \pi^0,$

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

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

Ξ^* Generator Refinement

- Started with generator for general reaction $\gamma\, p \rightarrow K^+ K^+ \Xi^- \pi^0$ and modified from there

- Taking the initial reaction as $\gamma\, p \rightarrow K\, Y^*$

- Mandelstam variables have relationship:
  - $s+t+u = m_\gamma^2 + m_p^2 + m_K^2 + m_{Y*}^2$

- We can lock down the kinematics of the initial reaction by specifying s, t and m_{Y*}

- Started with Mandelstam s and t

Ξ^* Comparison of Reconstructed MC to Actual Data

For the general reaction:

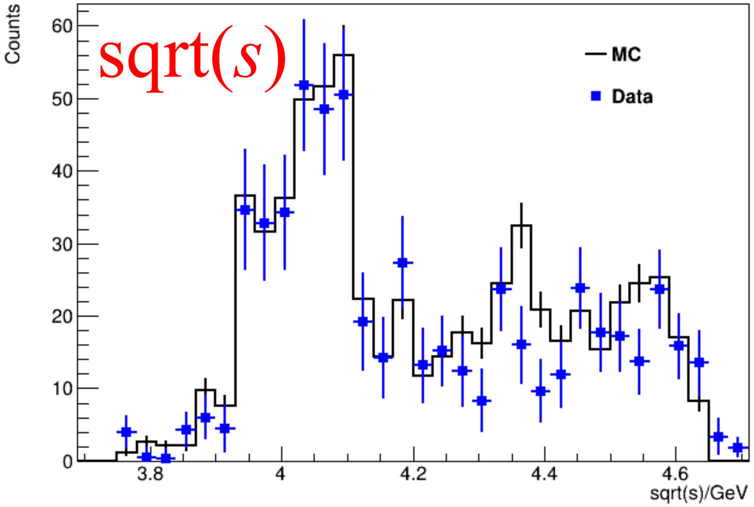
- 1st : Set t-slope (parameter b in $Ae^{-b|t|}$) to 1.138/GeV^2 assuming $\gamma\, p \rightarrow K_{\text{fast}}\, Y^*$
- 2nd : Shaped mass[Y^*] and mass[Ξ^*]
- 3rd : Shaping K_{slow} distribution assuming $Y^* \rightarrow K_{\text{slow}}\, \Xi^*$

For $\gamma\, p \rightarrow K^+ K^+ \Xi^-(1530)$

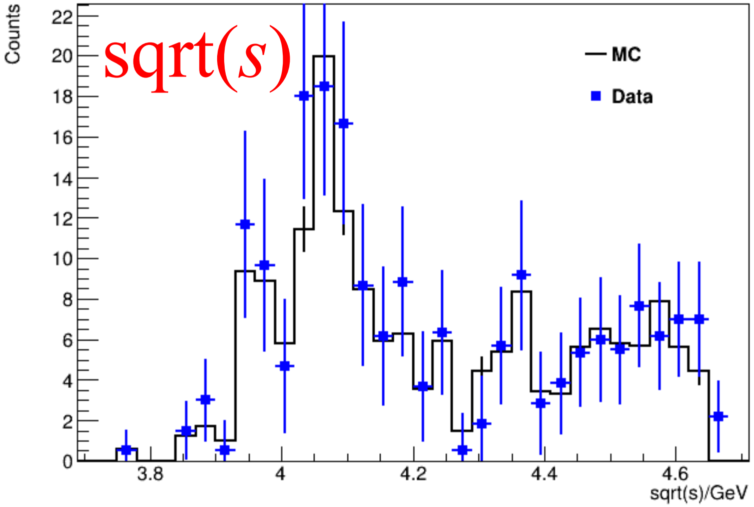
- Start with general reaction and modify each step as required

Ξ^* Comparison of Reconstructed MC to Actual Data

General reaction

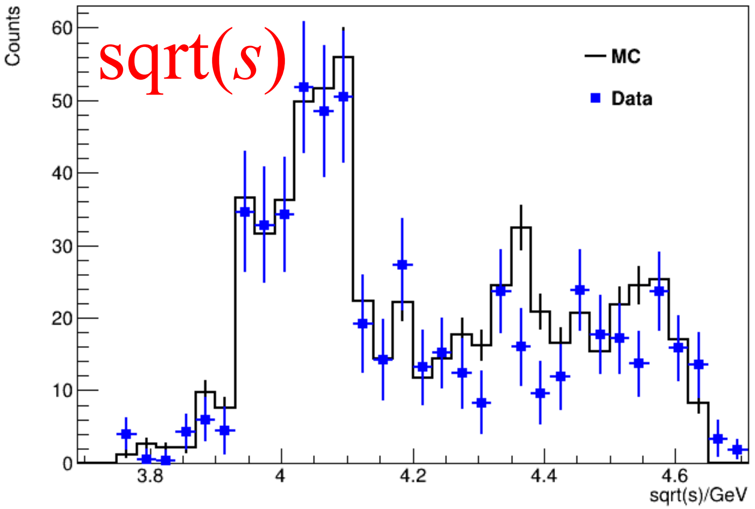


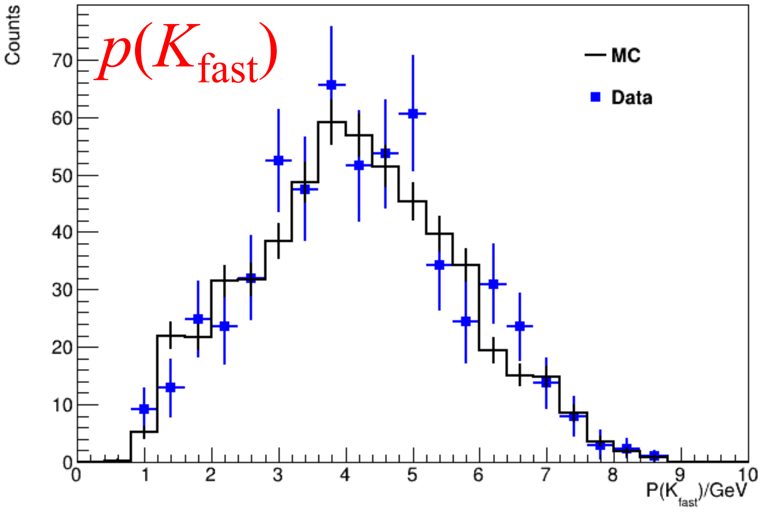
$\gamma p \rightarrow K^+K^+\Xi^-(1530)$



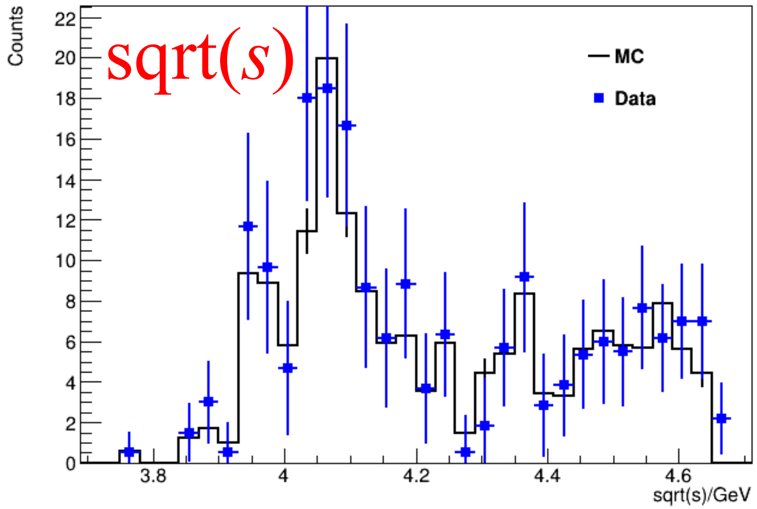
Ξ^* Comparison of Reconstructed MC to Actual Data

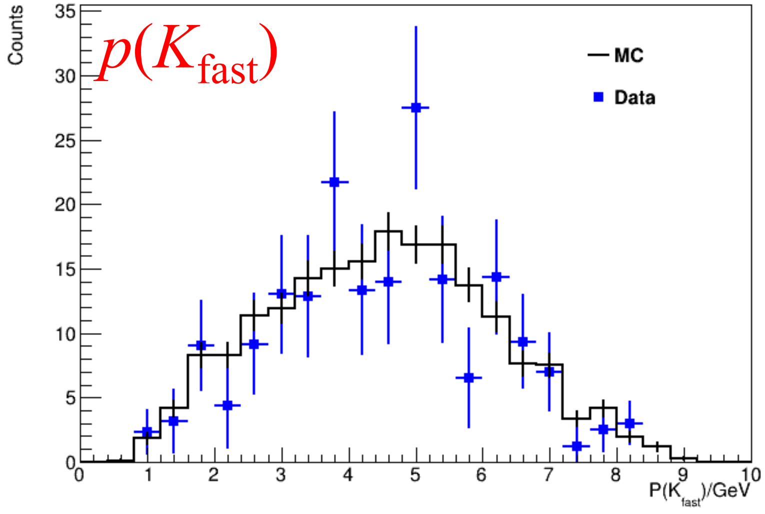
General reaction





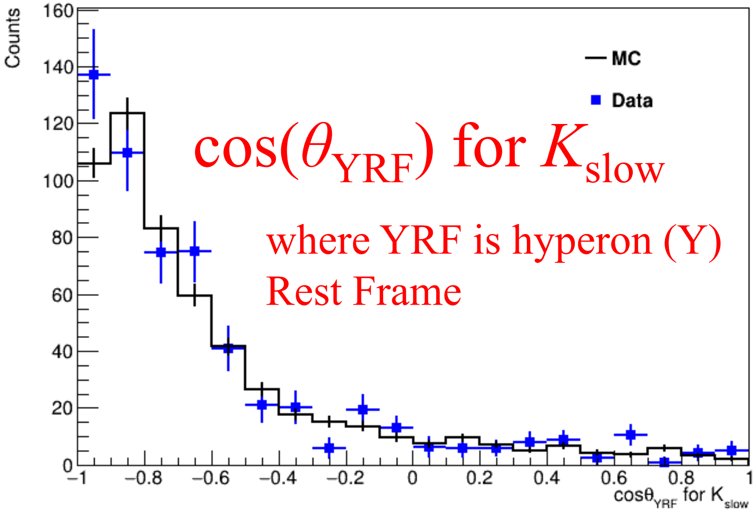
$\gamma\, p \rightarrow K^+K^+\Xi^-(1530)$





Ξ^* Comparison of Reconstructed MC to Actual Data

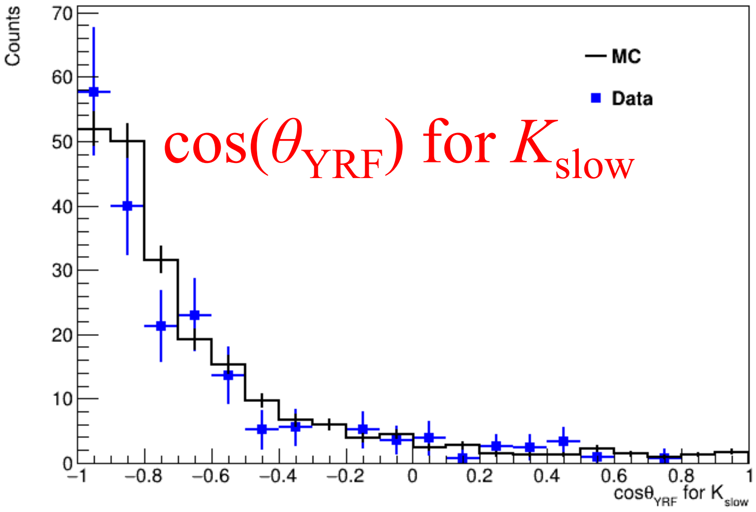
General reaction



$\cos(\theta_{YRF})$ for K_{slow}

where YRF is hyperon (Y) Rest Frame

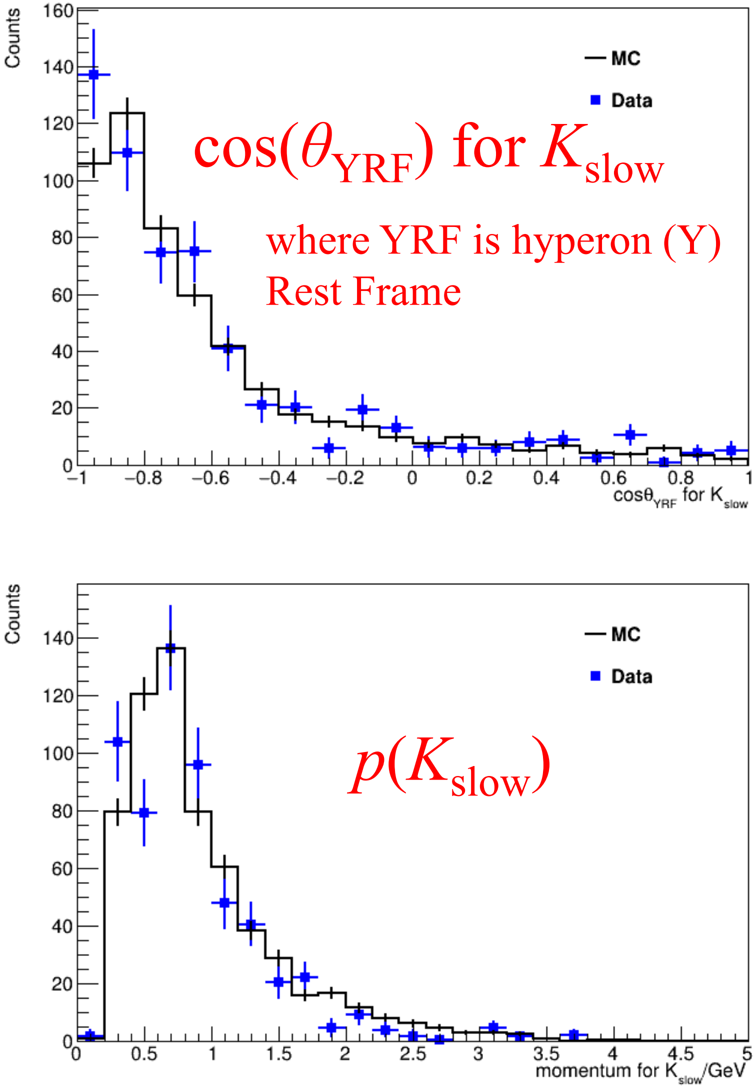
$\gamma\, p \rightarrow K^+K^+\Xi^-(1530)$



$\cos(\theta_{YRF})$ for K_{slow}

Ξ^* Comparison of Reconstructed MC to Actual Data

General reaction

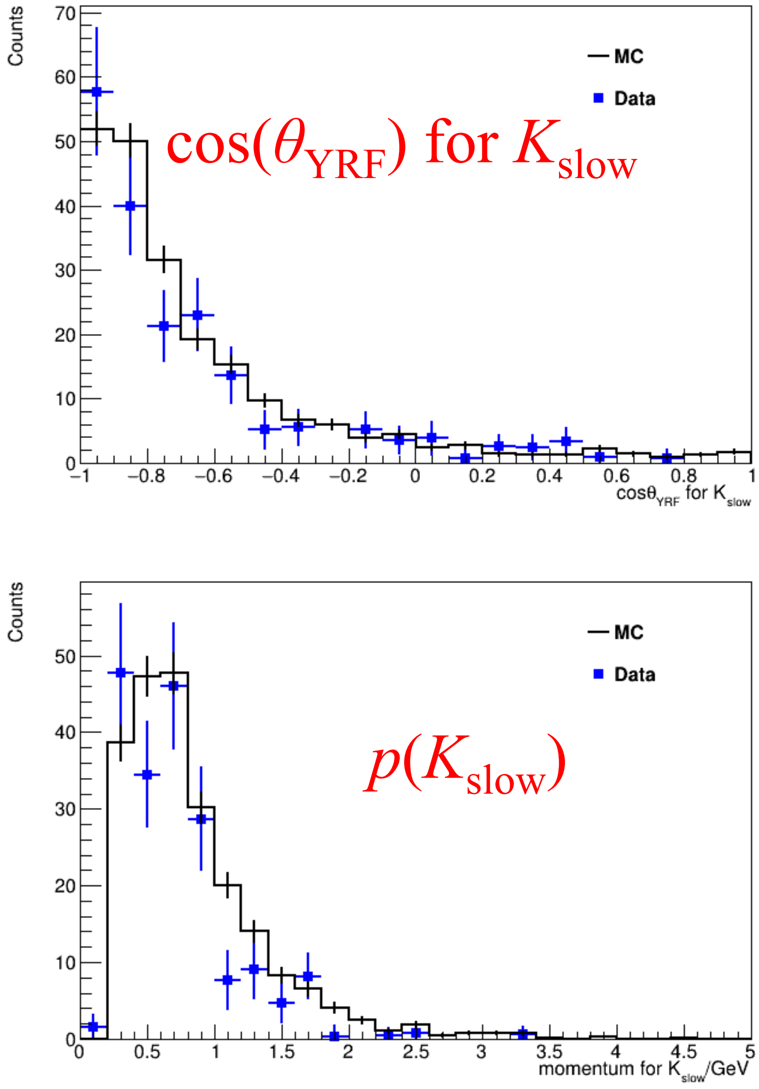


$\cos(\theta_{\mathrm{YRF}})$ for K_{slow}

where YRF is hyperon (Y) Rest Frame

$p(K_{\mathrm{slow}})$

$\gamma\, p \rightarrow K^+ K^+ \Xi^-(1530)$

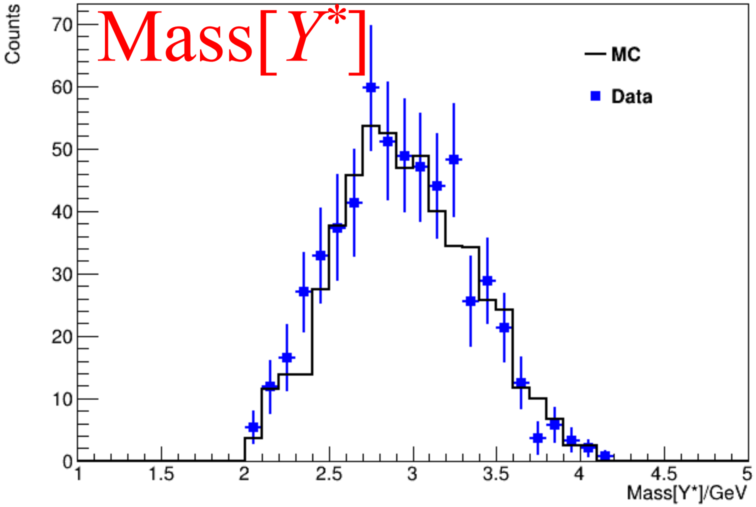


$\cos(\theta_{\mathrm{YRF}})$ for K_{slow}

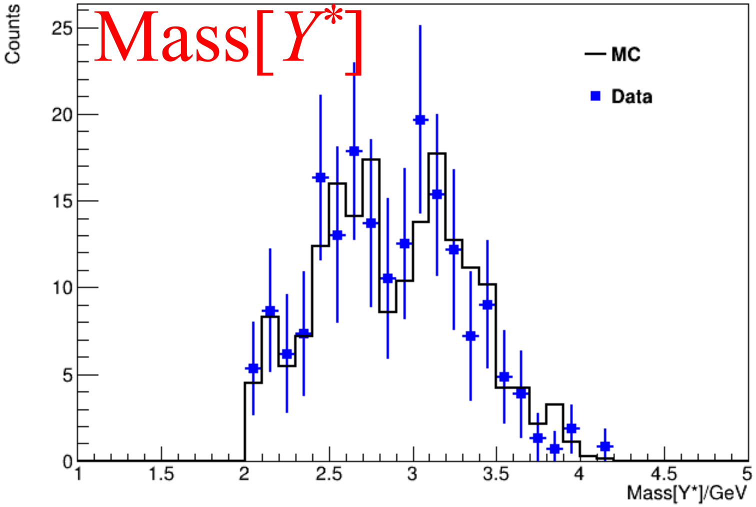
$p(K_{\mathrm{slow}})$

Ξ^* Comparison of Reconstructed MC to Actual Data

General reaction

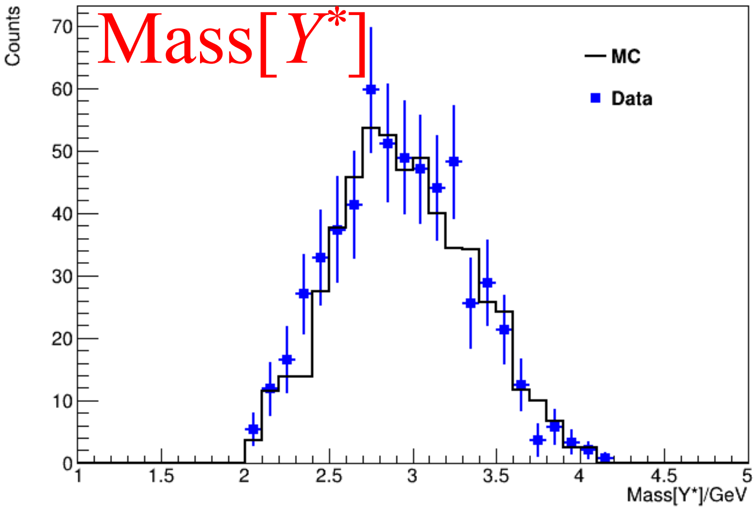


$\gamma\, p \rightarrow K^+ K^+ \Xi^-(1530)$

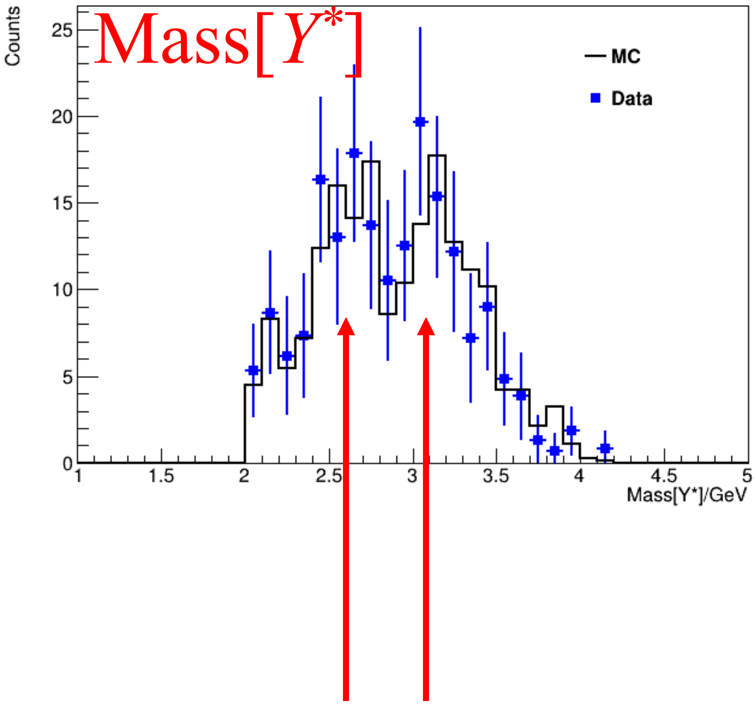


Ξ^* Comparison of Reconstructed MC to Actual Data

General reaction



$\gamma\, p \rightarrow K^+K^+\Xi^-(1530)$

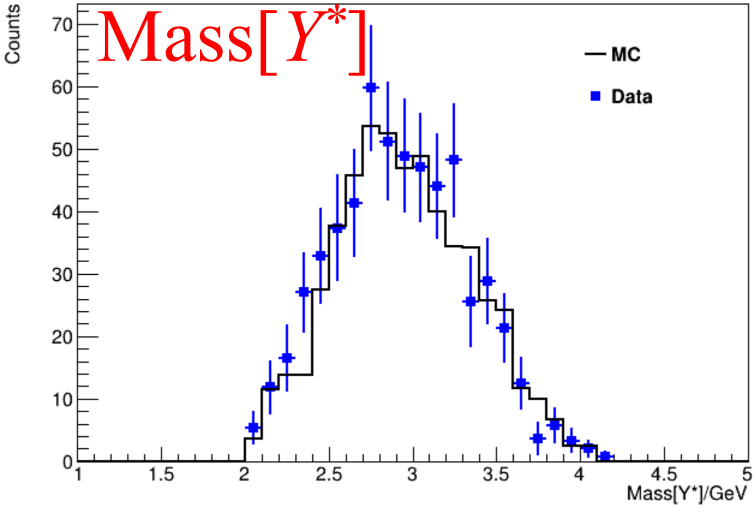


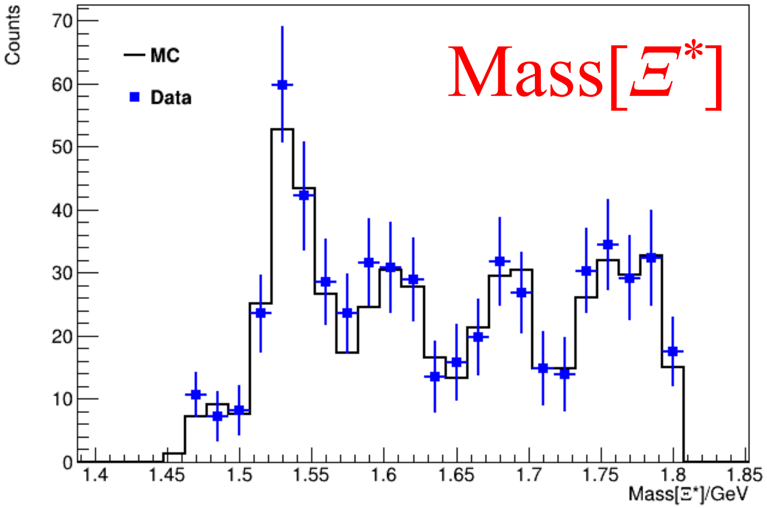
Resonances in the Y^*?

Will explore more in later slides

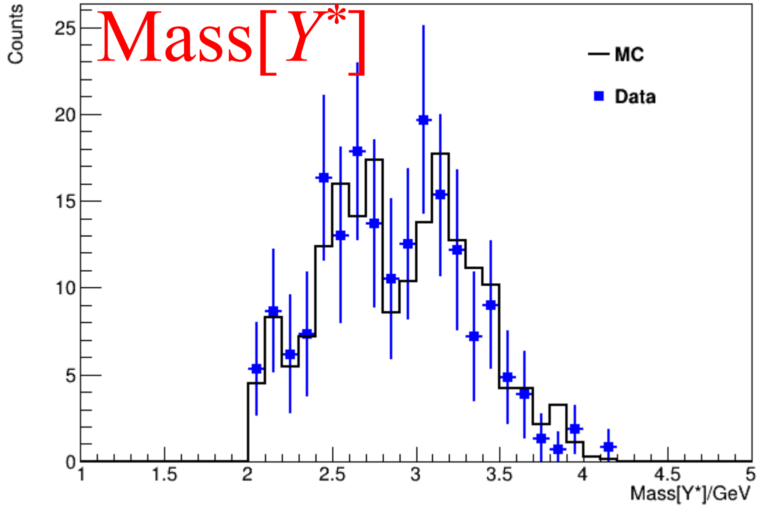
Ξ^* Comparison of Reconstructed MC to Actual Data

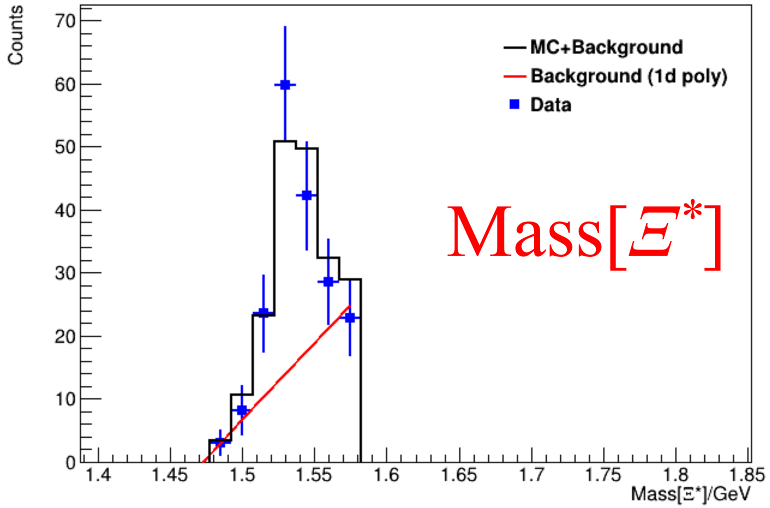
General reaction





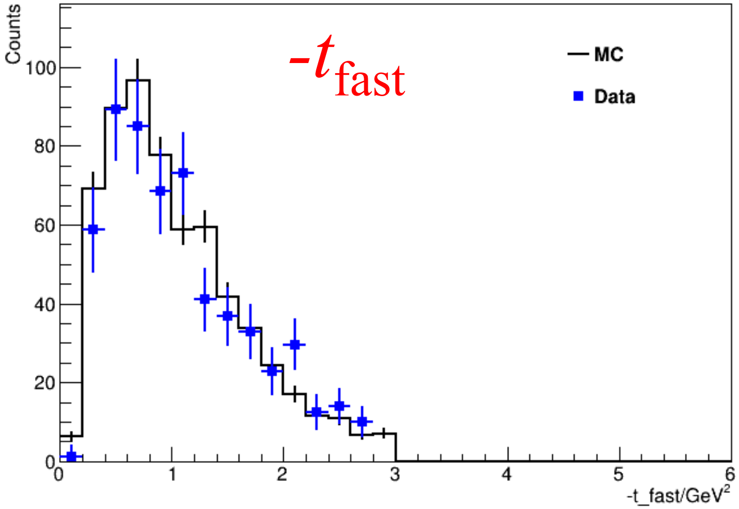
$\gamma\, p \rightarrow K^+K^+\Xi^-(1530)$



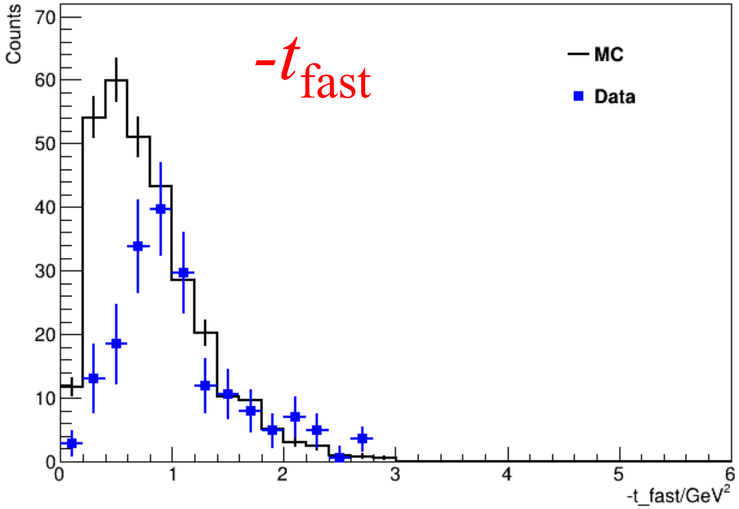


Ξ^* Comparison of Reconstructed MC to Actual Data

General reaction

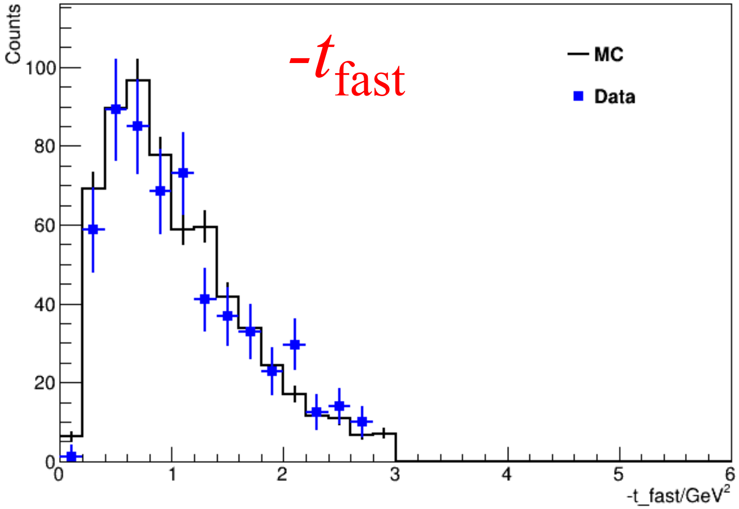


$\gamma\, p \rightarrow K^+ K^+ \Xi^-(1530)$

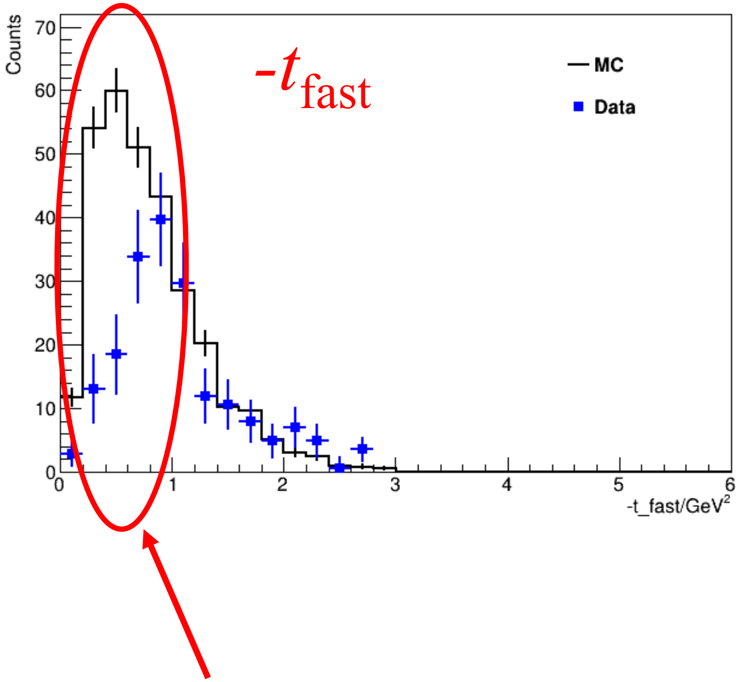


Ξ^* Comparison of Reconstructed MC to Actual Data

General reaction



$\gamma\, p \rightarrow K^+ K^+ \Xi^-(1530)$



Not good ☹

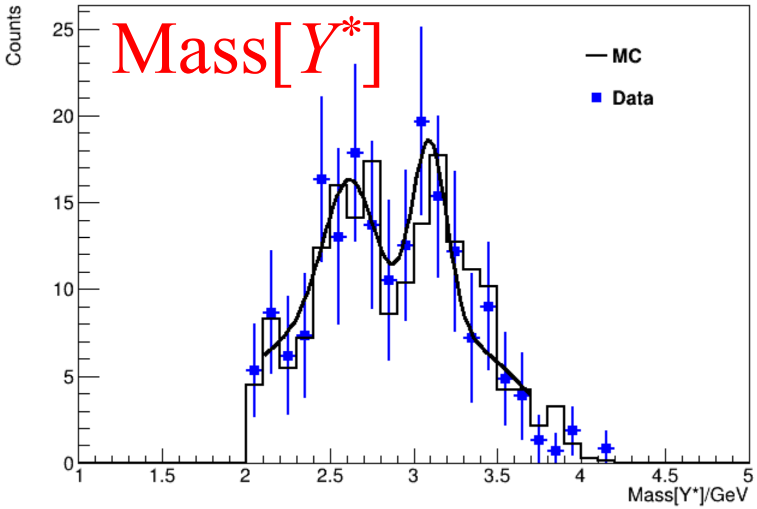
Y^* bumps compared to PDG Σ bumps

Y^* bumps compared to PDG Σ bumps

$\gamma\, p \rightarrow K^+ Y^*$, where $Y^* \rightarrow K^+ \Xi^-(1530)$ and $\Xi^-(1530) \rightarrow \Xi^- \pi^0$

Y^* bumps compared to PDG Σ bumps

$\gamma\, p \rightarrow K^+ Y^*$, where $Y^* \rightarrow K^+ \Xi^-(1530)$ and $\Xi^-(1530) \rightarrow \Xi^- \pi^0$

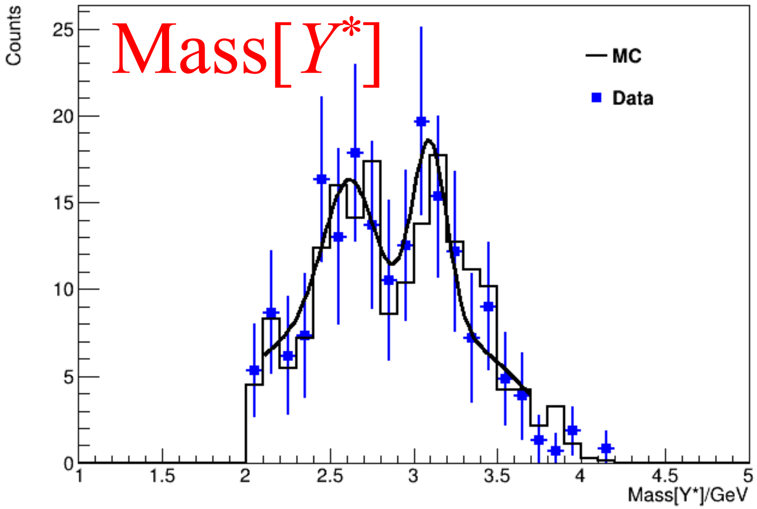


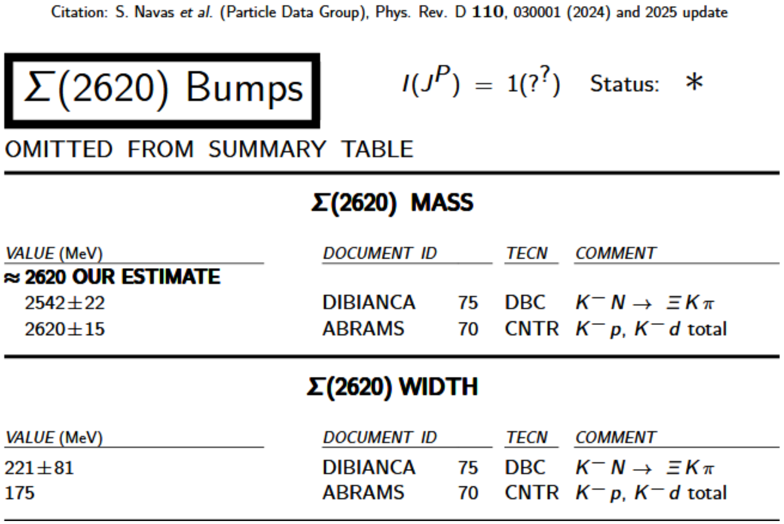
First bump:

- Center = 2610 +/- 81 MeV
- FWHM = 353 +/- 270 MeV

Y^* bumps compared to PDG Σ bumps

$\gamma\, p \rightarrow K^+ Y^*$, where $Y^* \rightarrow K^+ \Xi^-(1530)$ and $\Xi^-(1530) \rightarrow \Xi^- \pi^0$





Citation: S. Navas *et al.* (Particle Data Group), Phys. Rev. D **110**, 030001 (2024) and 2025 update

$\Sigma(2620)$ Bumps $I(J^P) = 1(?^?)$ Status: $*$

OMITTED FROM SUMMARY TABLE

Σ(2620) MASS

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
≈ 2620 OUR ESTIMATE				
2542±22	DIBIANCA	75	DBC	$K^- N \to \Xi K \pi$
2620±15	ABRAMS	70	CNTR	$K^- p$, $K^- d$ total

Σ(2620) WIDTH

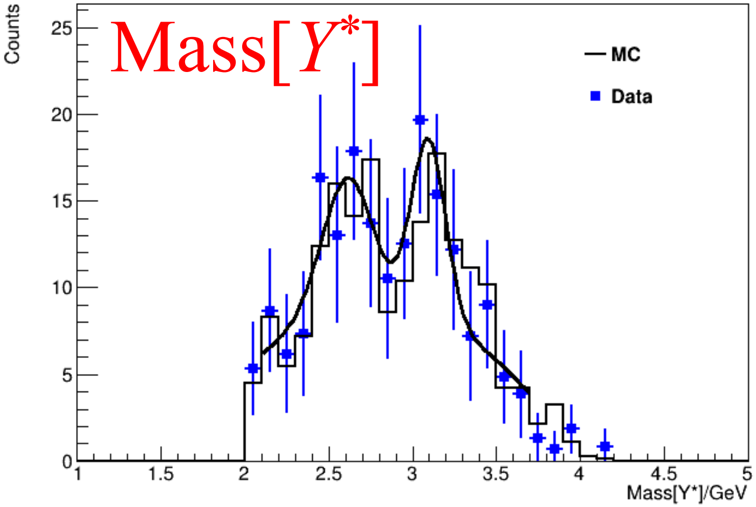
VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
221±81	DIBIANCA	75	DBC	$K^- N \to \Xi K \pi$
175	ABRAMS	70	CNTR	$K^- p$, $K^- d$ total

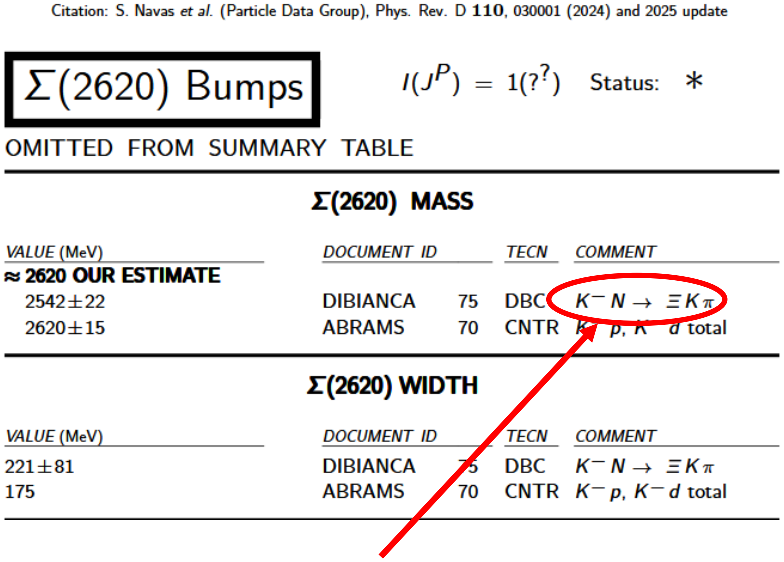
First bump:

- Center = 2610 +/- 81 MeV
- FWHM = 353 +/- 270 MeV

Y^* bumps compared to PDG Σ bumps

$\gamma\, p \rightarrow K^+ Y^*$, where $Y^* \rightarrow K^+ \Xi^-(1530)$ and $\Xi^-(1530) \rightarrow \Xi^- \pi^0$




Citation: S. Navas *et al.* (Particle Data Group), Phys. Rev. D **110**, 030001 (2024) and 2025 update

Σ(2620) Bumps $I(J^P) = 1(?^?)$ Status: ∗

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First bump:

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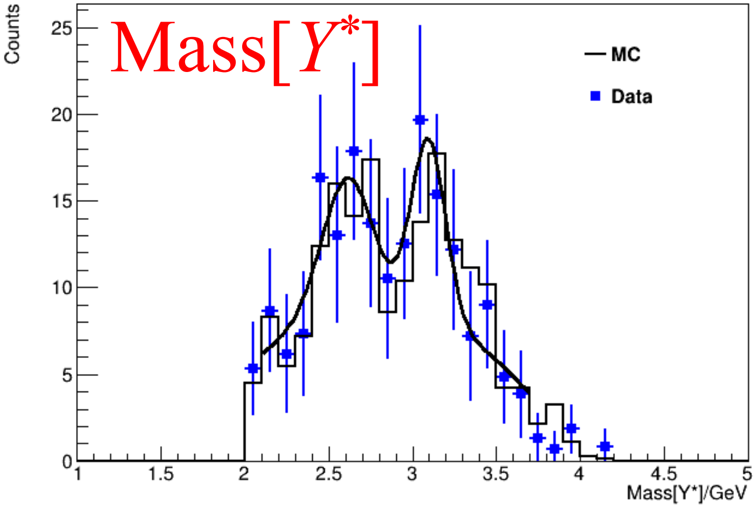
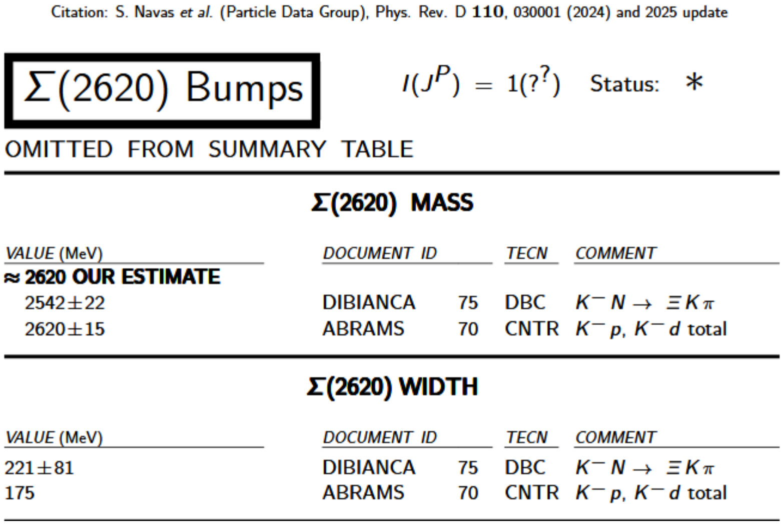
Similar final state to

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

Y^* bumps compared to PDG Σ bumps

$\gamma\, p \rightarrow K^+ Y^*$, where $Y^* \rightarrow K^+ \Xi^-(1530)$ and $\Xi^-(1530) \rightarrow \Xi^- \pi^0$




Citation: S. Navas *et al.* (Particle Data Group), Phys. Rev. D **110**, 030001 (2024) and 2025 update

$\Sigma(2620)$ Bumps $I(J^P) = 1(?^?)$ Status: ∗

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Σ(2620) WIDTH

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
221±81	DIBIANCA	75	DBC	$K^- N \rightarrow \Xi K \pi$
175	ABRAMS	70	CNTR	$K^- p$, $K^- d$ total

First bump:

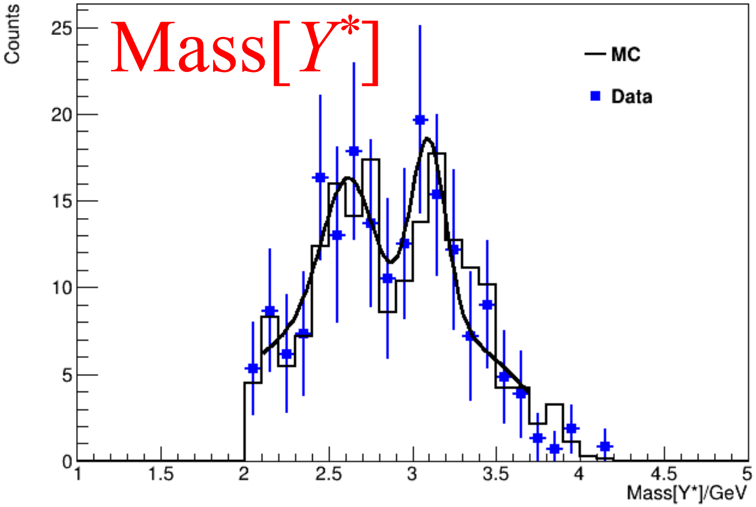
- Center = 2610 +/- 81 MeV
- FWHM = 353 +/- 270 MeV

Second bump:

- Center = 3093 +/- 55 MeV
- FWHM = 240 +/- 167

Y^* bumps compared to PDG Σ bumps

$\gamma\, p \rightarrow K^+ Y^*$, where $Y^* \rightarrow K^+ \Xi^-(1530)$ and $\Xi^-(1530) \rightarrow \Xi^- \pi^0$



First bump:

- Center = 2610 +/- 81 MeV
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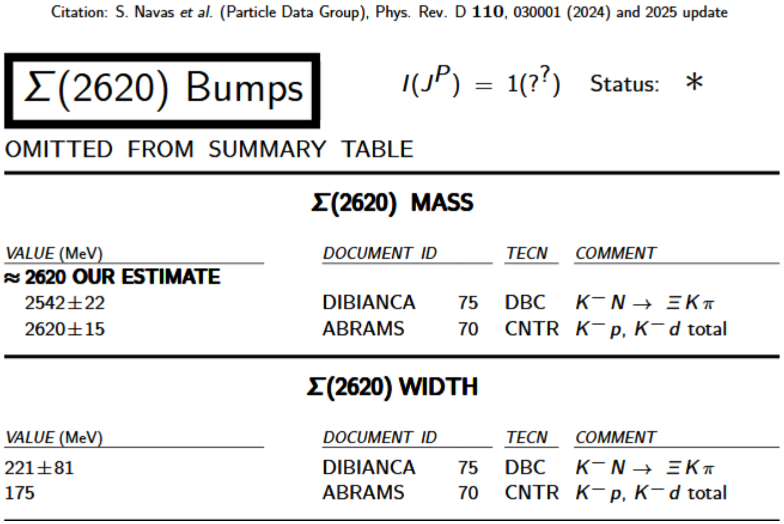
- Center = 3093 +/- 55 MeV
- FWHM = 240 +/- 167



Citation: S. Navas *et al.* (Particle Data Group), Phys. Rev. D **110**, 030001 (2024) and 2025 update

$\Sigma(2620)$ Bumps $I(J^P) = 1(?^?)$ Status: ∗

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VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
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$\Sigma(2620)$ WIDTH

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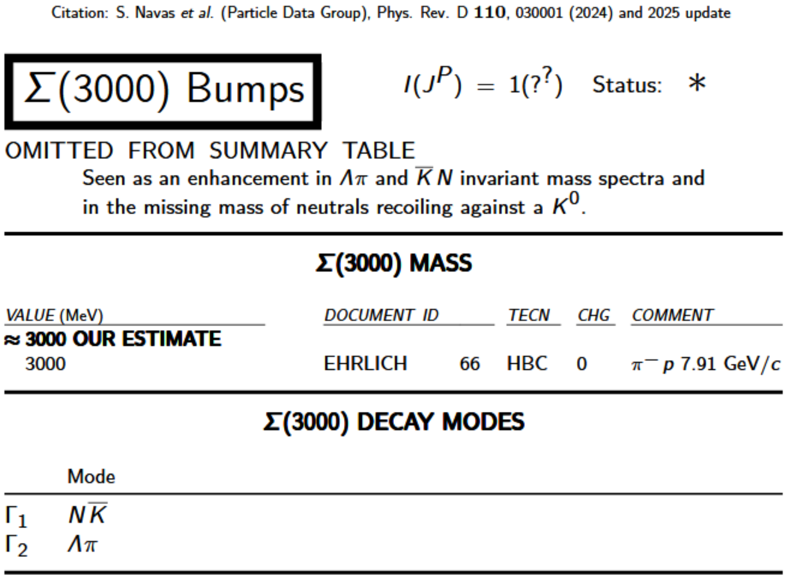
221±81	DIBIANCA	75	DBC	$K^- N \rightarrow \Xi K \pi$
175	ABRAMS	70	CNTR	$K^- p$, $K^- d$ total



Citation: S. Navas *et al.* (Particle Data Group), Phys. Rev. D **110**, 030001 (2024) and 2025 update

$\Sigma(3000)$ Bumps $I(J^P) = 1(?^?)$ Status: ∗

OMITTED FROM SUMMARY TABLE

Seen as an enhancement in $\Lambda\pi$ and $\overline{K}N$ invariant mass spectra and in the missing mass of neutrals recoiling against a K^0.

$\Sigma(3000)$ MASS

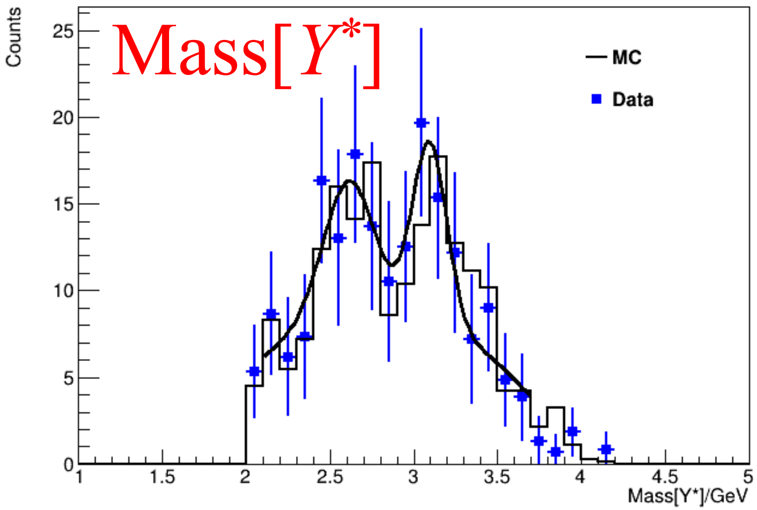
VALUE (MeV)	*DOCUMENT ID*		*TECN*	*CHG*	*COMMENT*
≈ 3000 OUR ESTIMATE					
3000	EHRLICH	66	HBC	0	$\pi^- p$ 7.91 GeV/c

$\Sigma(3000)$ DECAY MODES

	Mode
Γ_1	$N\overline{K}$
Γ_2	$\Lambda\pi$

Y^* bumps compared to PDG Σ bumps

$\gamma\, p \to K^+ Y^*$, where $Y^* \to K^+ \Xi^-(1530)$ and $\Xi^-(1530) \to \Xi^- \pi^0$



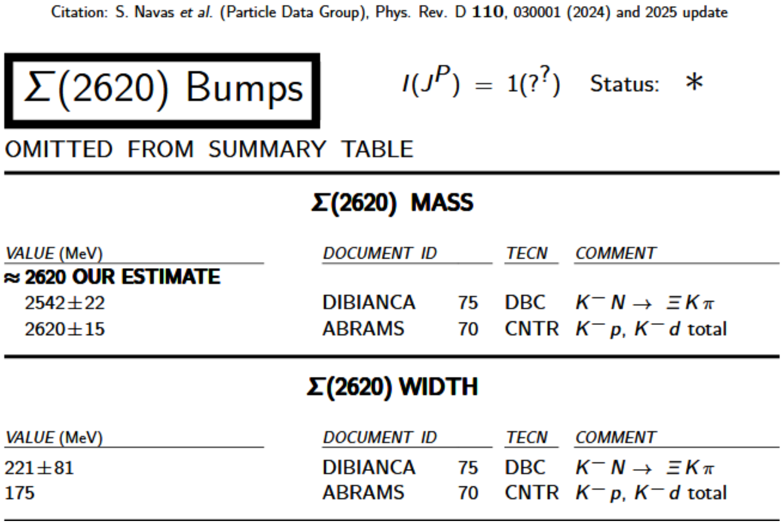
First bump:

- Center = 2610 +/- 81 MeV
- FWHM = 353 +/- 270 MeV

Second bump:

- Center = 3093 +/- 55 MeV
- FWHM = 240 +/- 167

Interesting, but needs more statistics



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$\Sigma(2620)$ Bumps

$I(J^P) = 1(?^?)$ Status: ∗

OMITTED FROM SUMMARY TABLE

$\Sigma(2620)$ MASS

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$\Sigma(2620)$ WIDTH

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221±81	DIBIANCA	75	DBC	$K^- N \to \Xi K \pi$
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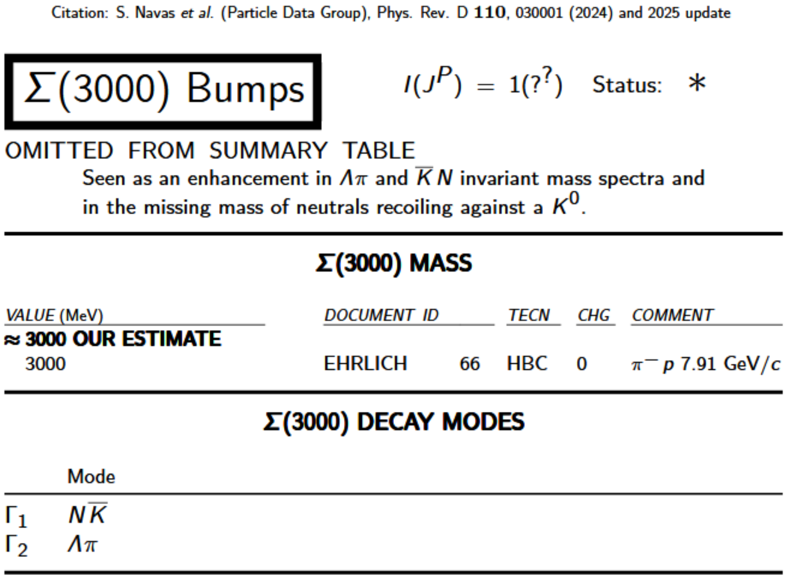

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$\Sigma(3000)$ Bumps

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$\Sigma(3000)$ DECAY MODES

	Mode
Γ_1	$N\overline{K}$
Γ_2	$\Lambda\pi$

Title