

Studio della $\Sigma(1385) \rightarrow \Lambda \pi$ in pp @ 10 TeV

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Outline

- $\Sigma(1385)$ ID Card
- Motivations
- Framework
- Kinematics of Generated Particles
- Invariant Mass Distribution
- Extracting The Signals
- Significance
- Conclusions & Next Steps...



$\Sigma(1385)$ ID card - 1

- Quantum numbers: $S=-1, I (J^P)= 1 (3/2)^+$
- Three Charge States
- Quark composition:

- $\Sigma^{*+} (uus) \quad \Sigma^{*0} (uds) \quad \Sigma^{*-} (dds)$

$\Sigma(1385)^+$ mass $m = 1382.8 \pm 0.4$ MeV

$\Sigma(1385)^0$ mass $m = 1383.7 \pm 1.0$ MeV

$\Sigma(1385)^-$ mass $m = 1387.2 \pm 0.5$ MeV

$\Sigma(1385)^+$ full width $\Gamma = 35.8 \pm 0.8$ MeV

$\Sigma(1385)^0$ full width $\Gamma = 36 \pm 5$ MeV

$\Sigma(1385)^-$ full width $\Gamma = 39.4 \pm 2.1$ MeV

$\Sigma(1385)$ ID card - 2

- Decay Channels

$\Sigma(1385)$ DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	ρ (MeV/c)
$\Lambda\pi$	$(87.0 \pm 1.5) \%$		208
$\Sigma\pi$	$(11.7 \pm 1.5) \%$		129
$\Lambda\gamma$	$(1.3 \pm 0.4) \%$		241
$\Sigma^-\gamma$	$< 2.4 \times 10^{-4}$	90%	173

- Decay is strong (unlike $\Xi\dots$)

- Broad peak! ($\Gamma \sim 35$ MeV)
- The decay vertex is not distinguishable from the primary one due to short lifetimes!



Motivations

- Due to its strange quark content and high mass, $\Sigma(1385)$ may give additional information about strangeness enhancement, one of the possible signatures of the Quark Gluon Plasma

Sevil Salur for the STAR Collaboration, $\Sigma(1385)$ RESONANCE STUDIES WITH STAR AT $\sqrt{s_{NN}} = 200$ GEV

- The comparison between yields in pp and PbPb can provide an estimate of time-span between chemical and thermal freeze-out since it determines the net effect of re-scattering and regeneration on the total yield

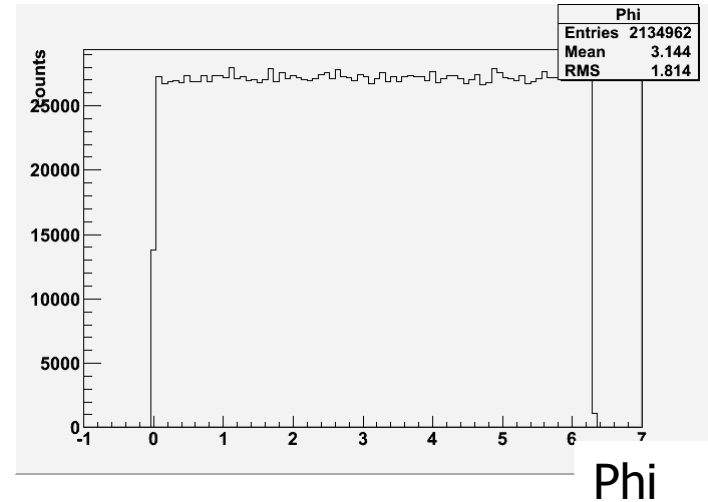
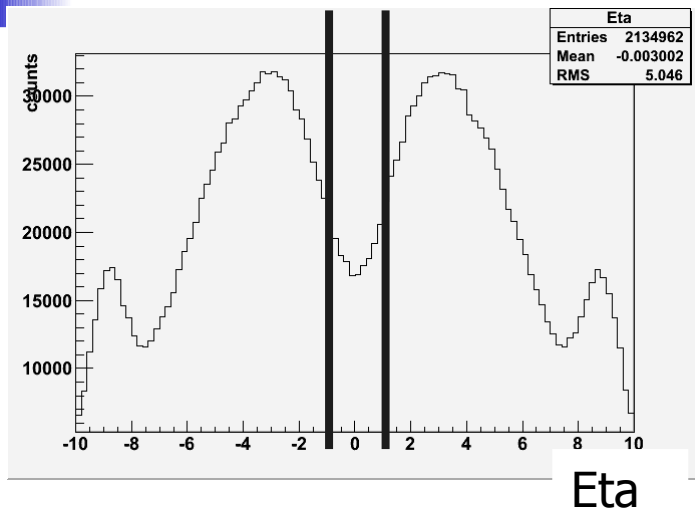
STAR Collaboration, Strange Baryon Resonance Production in $\sqrt{s_{NN}} 200$ GeV p+p and Au+Au Collisions



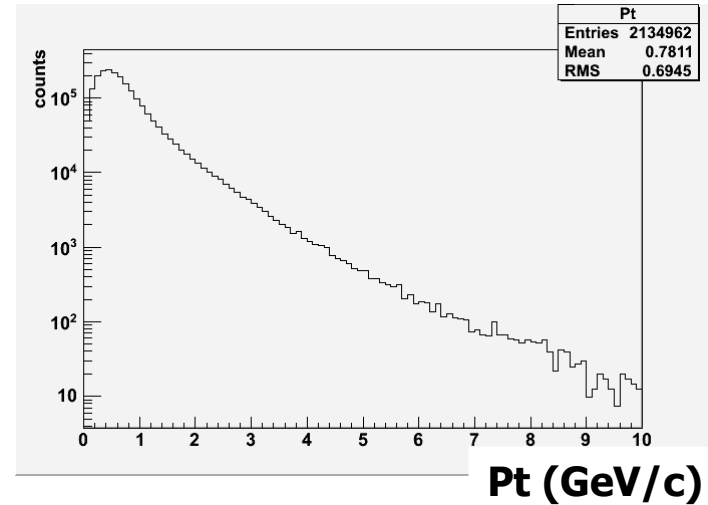
Framework

- 7 million events from LHC09a4@10TeV
- Root_v5-23-02
- Aliroot_v4-16-Rev-07
- PDGCheckTask
- AliAnalysisTaskSigma1385 based on AliAnalysisTaskCheckCascade (A. Maire)
- Same cuts except on secondary vertex

Kinematics of Generated Particles

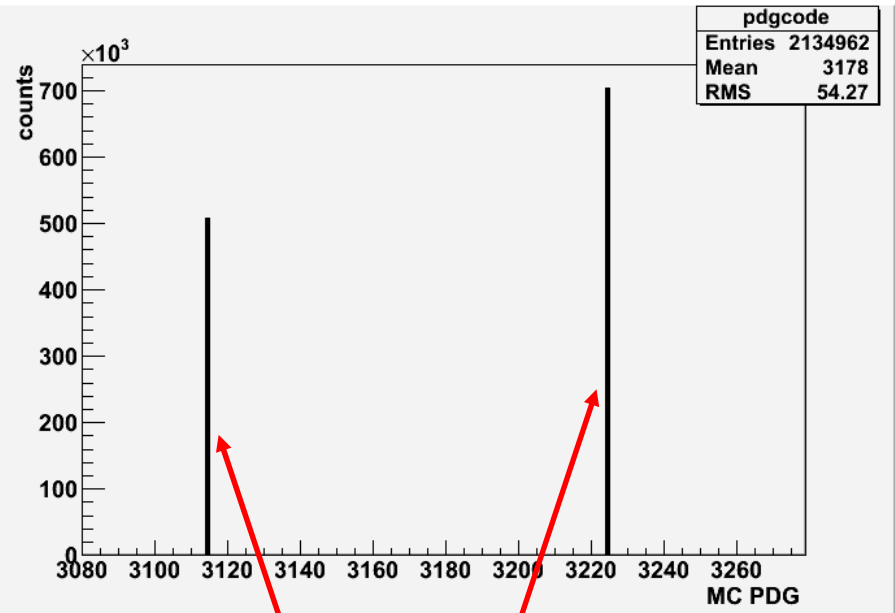
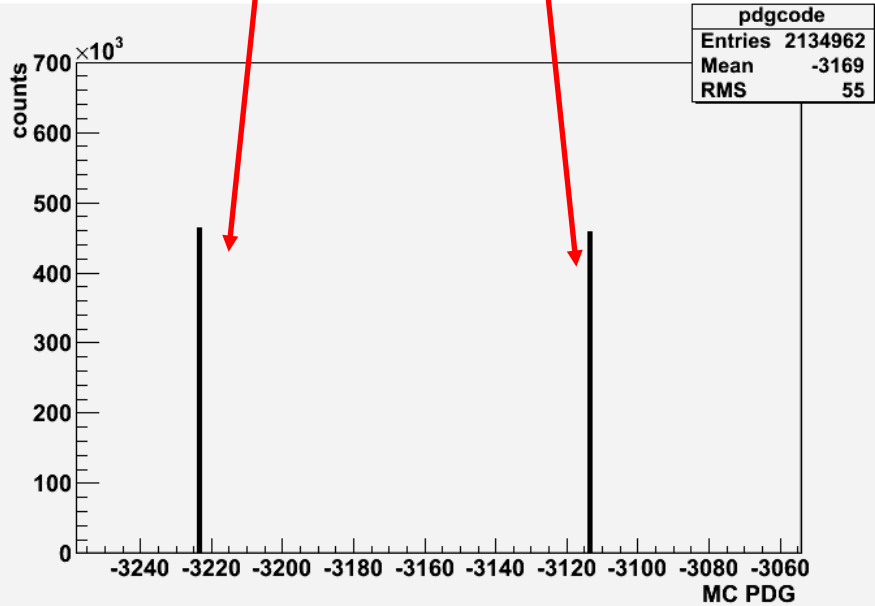


All four states
(particle and
antiparticle)



Kinematics of Generated Particles

Anti (Σ^{*+}) Anti (Σ^{*-})



Σ^{*-} Σ^{*+}

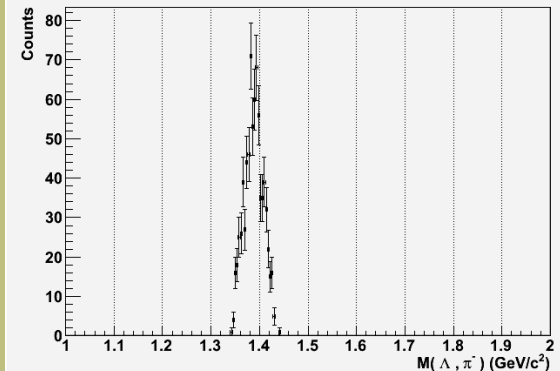
Reconstructed Particles: Invariant mass distributions

Study of $\Sigma^-(1385) \rightarrow \Lambda\pi^-$

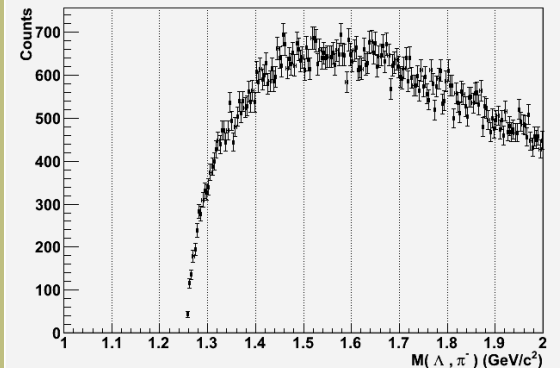
Best results so far...

Small trick: track index
from AliESDtrack!

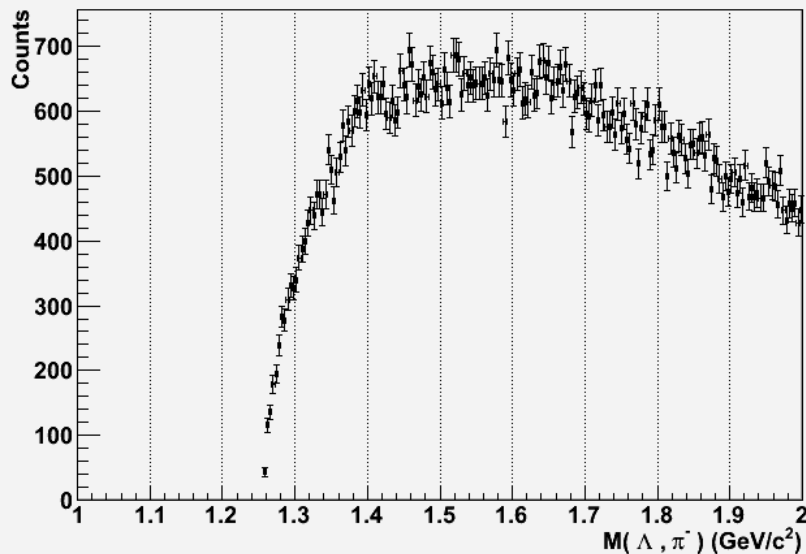
'True' $\Sigma(1385)^-$ from simulation



'True' background from simulation



$\Sigma(1385)^-$ candidates

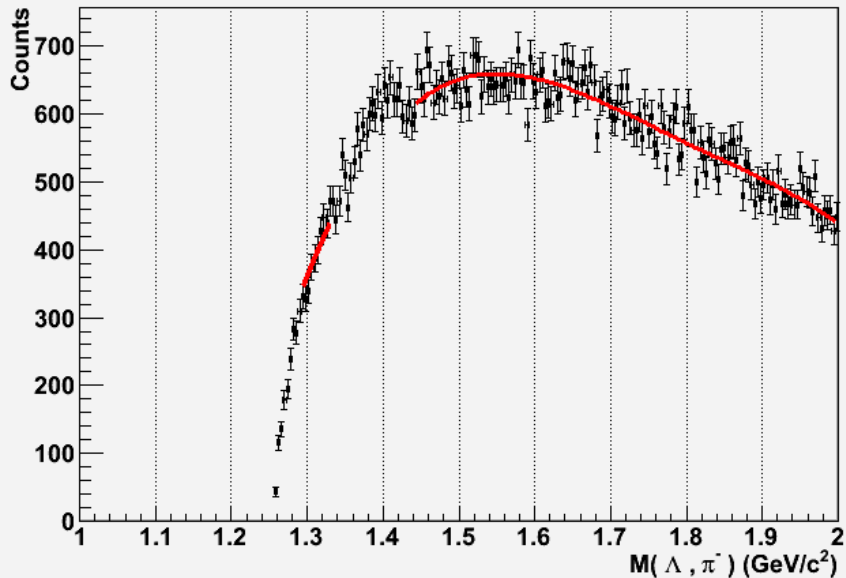


Extracting the signal - 1

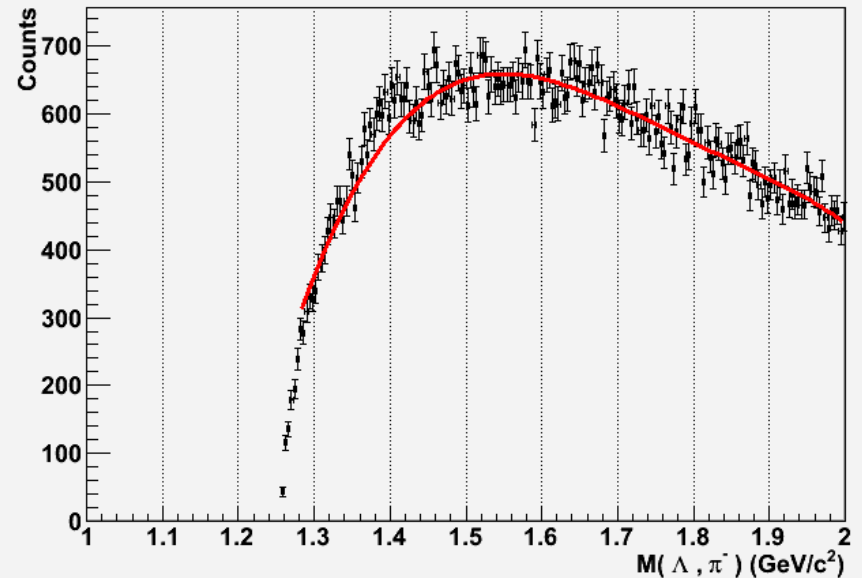
I. Polynomial fit in the no-signal region

II. Used to define background (BG) curve

$\Sigma(1385)^-$ candidates



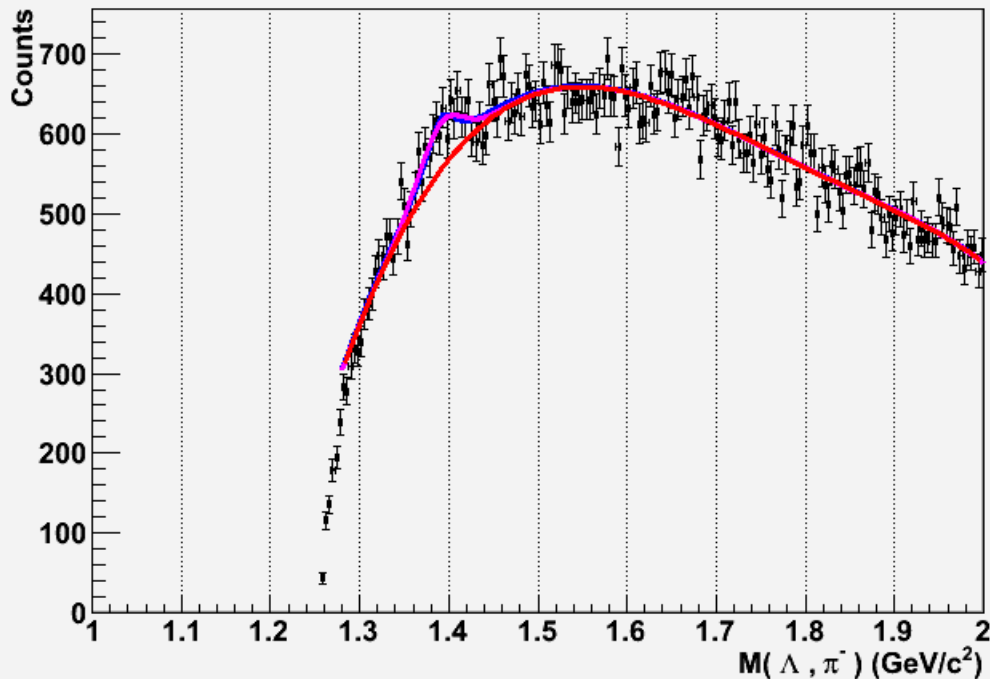
$\Sigma(1385)^-$ candidates



Extracting the signal – 2

III. Signal extraction

$\Sigma(1385)^+$ candidates



III.A BG+Breit-Wig

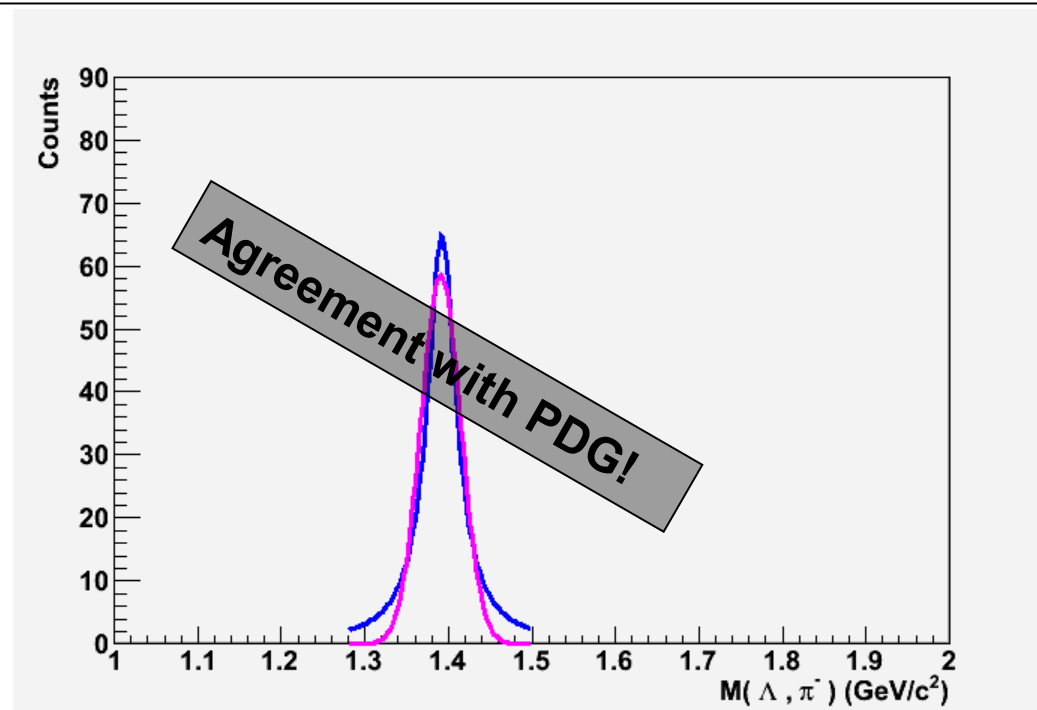
$$\text{Pol (7)} + I \left[\frac{\Gamma^2}{(x - x_0)^2 + \Gamma^2} \right]$$

III.B BG+Gaussian

$$\text{Pol (7)} + \frac{1}{\sqrt{2\pi} \sigma} e^{-\frac{(x - \mu)^2}{\sigma^2}}$$

Extracting the signal - 3

IV. Obtained signal



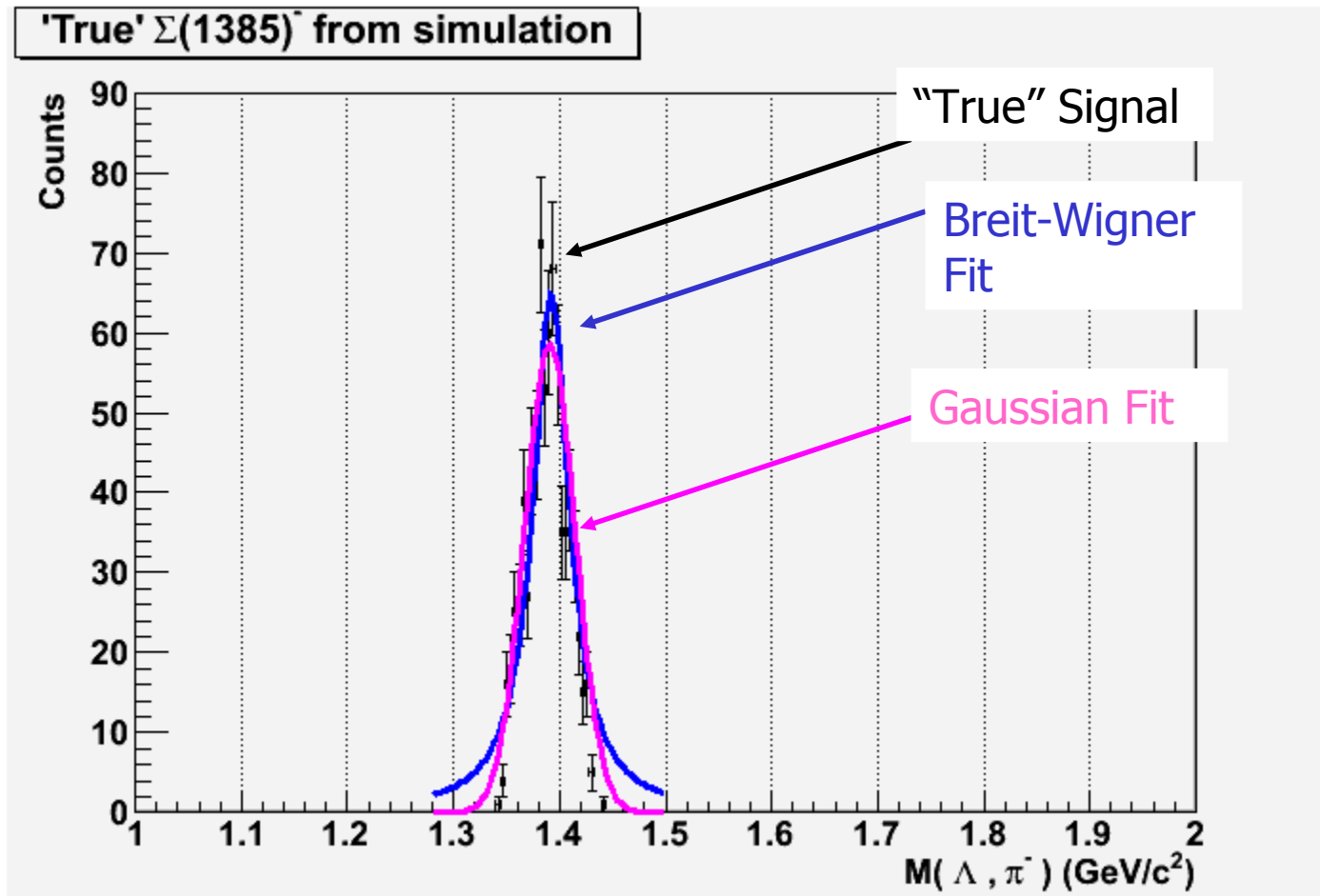
IV.A $M=1392 \pm 4$ MeV
 $\Gamma=42 \pm 9$ MeV

PDG Values:
 $M=1387.2 \pm 0.5$ MeV
 $\Gamma=39.4 \pm 2.1$ MeV

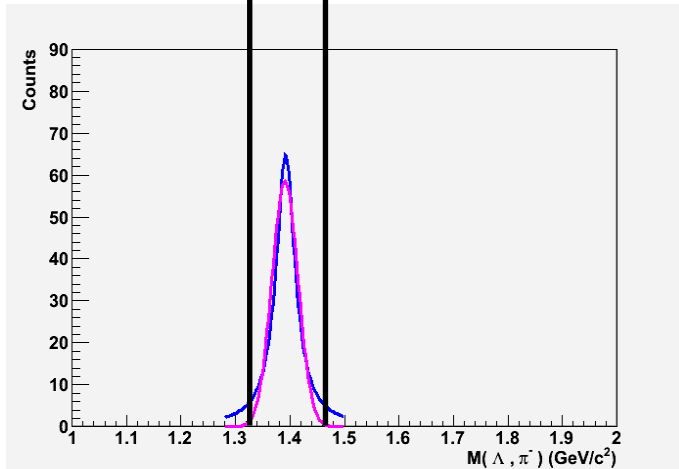
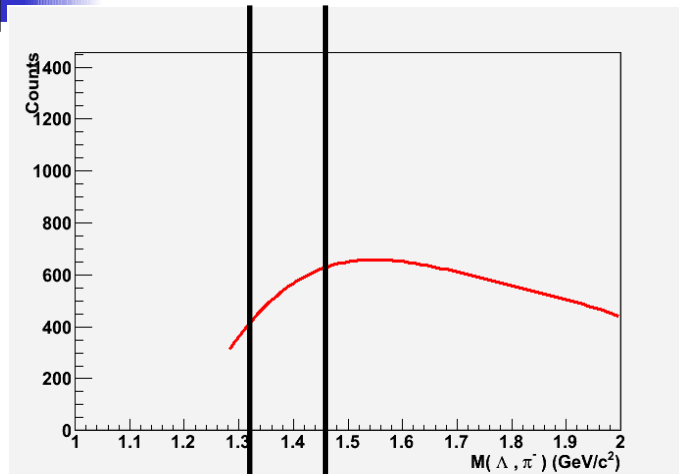
IV.B $M=1390 \pm 4$ MeV
 Γ (FWHM) $=56 \pm 14$ MeV

Extracting the signal - 4

V. Comparison with "True Signal"



Significance



1. Both background (BG) and signal (S) integrated between $\pm 3\sigma$

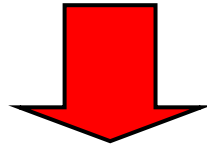
2. Significance
$$Sig = \frac{S}{\sqrt{BG}}$$

3. Sig ~ 6



Conclusions

7 Million Events pp @ 10 TeV



Possible to reconstruct $\Sigma(1385)$, 4 charge states

 Agreement with PDG (both Mass and Width)

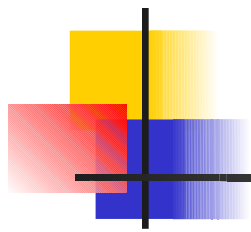
 Acceptable significance (high statistic used)

For better results \rightarrow 25-30 M events needed



Future prospects

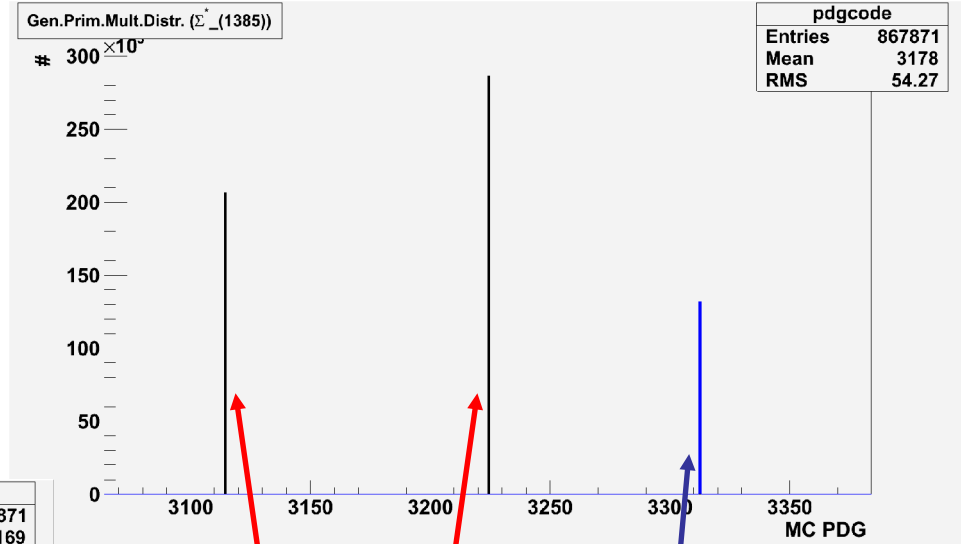
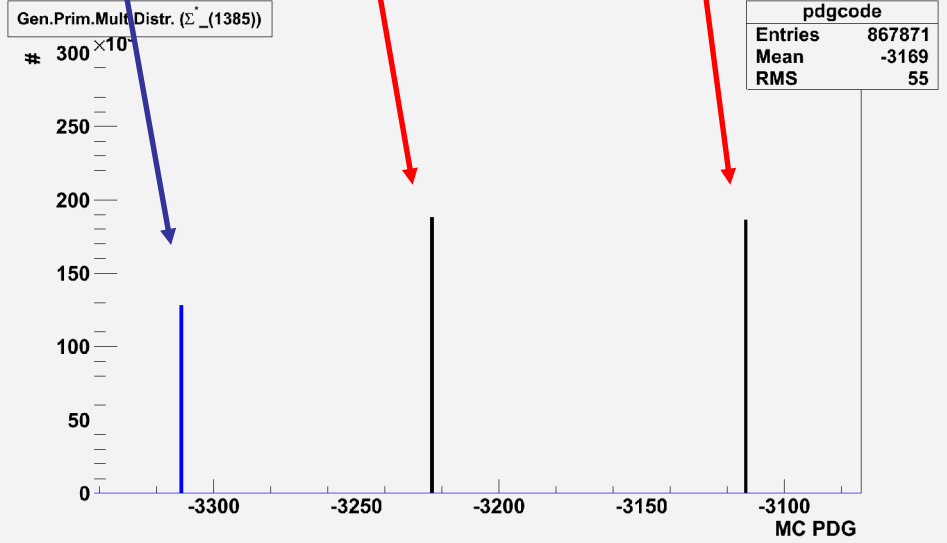
- Evaluation of systematic error in fit procedure
 - Techniques for background subtraction
 - Repeat the exercise in pt bins
 - Extracting the Ξ together with the Σ^* (cross checks...)
-
- Analysis from AOD
 - Participation to the analysis train



Backup Slides

Ξ and Σ (Generated)

Ξ^+ Anti (Σ^{*+}) Anti (Σ^{*-})



Σ^{*-} Σ^{*+} Ξ^-



Ratio Ξ / Σ^*

- Generated:

- $\Xi^- / \Sigma^{*-} = 0,6932 \pm 0,0003$
- $\Xi^- / (\Sigma^{*+} + \Sigma^{*-}) = 0,2678 \pm 0,0002$

- Reconstructed:

- $\Xi^- / \Sigma^{*-} = 1,031 \pm 0,005$
- $\Xi^- / (\Sigma^{*+} + \Sigma^{*-}) = 0,578 \pm 0,007$

BE CAREFULL!!
Acceptance
correction and fit
parameter fine
tuning needed!!

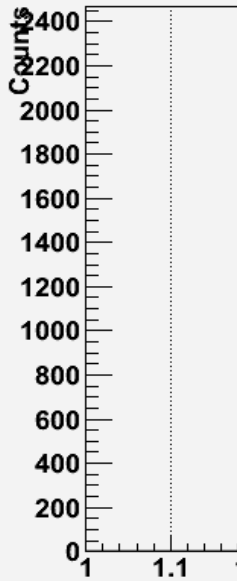


Masses and Widths (25 M events)

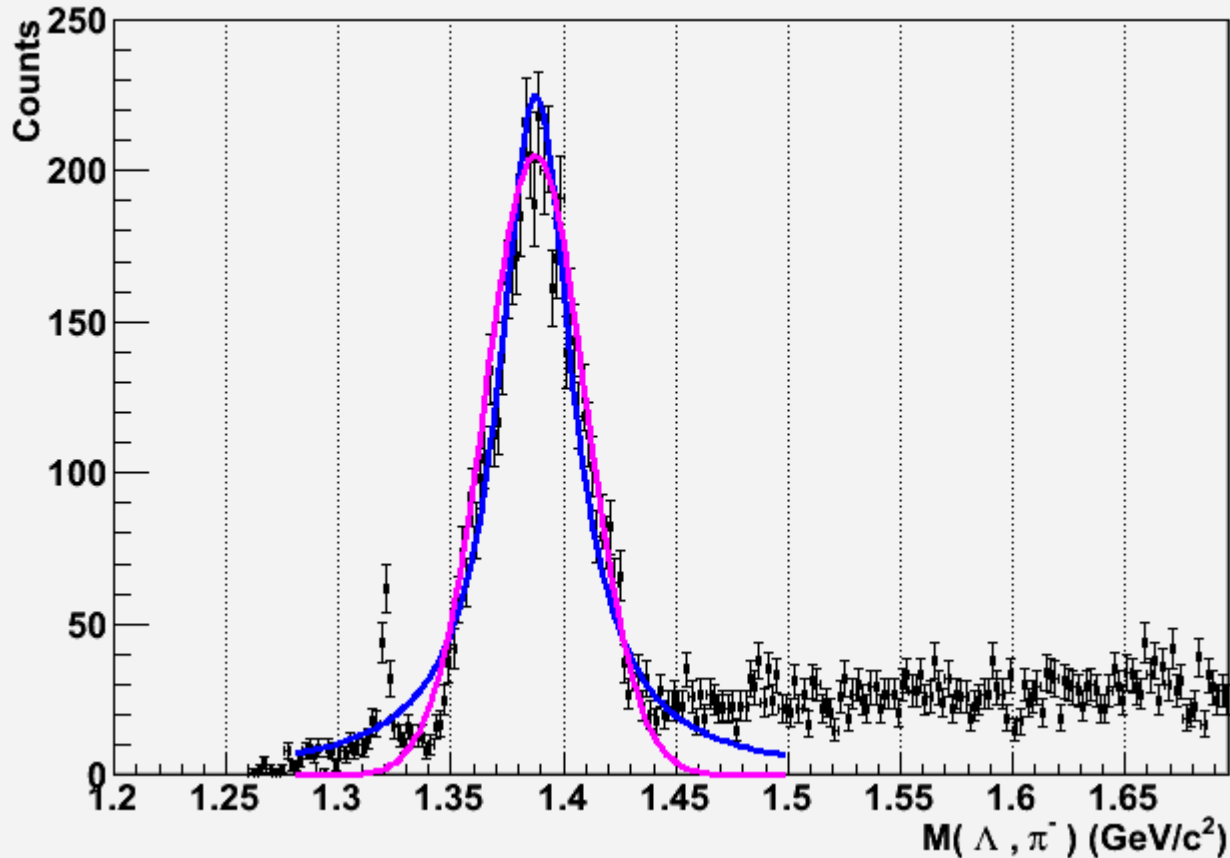
	Briet-Wigner Fit		Gaussian Fit	
	Mass (MeV)	Γ (MeV)	Mass (MeV)	Γ (MeV)
Σ^{*-}	$1387,6 \pm 1,6$	$38,7 \pm 3,1$	$1387,5 \pm 1,5$	$52,9 \pm 3,6$
Σ^{*+}	$1383, 2 \pm 1,3$	$29,9 \pm 3,1$	$1383, 8 \pm 1,5$	$52, 9 \pm 3,6$
Σ^{*-}	$1386,4 \pm 2,1$	$45,6 \pm 4,9$	$1387, 6 \pm 2,1$	$55,5 \pm 4,4$
Σ^{*+}	$1380, 2 \pm 1,8$	$45,4 \pm 4,4$	$1380, 7 \pm 1,8$	$58, 75 \pm 3,9$

Results with 25 M events

$\Sigma(1385)^-$ candid:



'True' $\Sigma(1385)^-$ from simulation



nd signal (S)

IV.A M
W

$\Gamma(\text{FWHM}) = 33 \pm 4 \text{ MeV}$