Σ hyperons reconstruction
by the missing mass method

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DPG Spring Meeting, Darmstadt
15.03.2016

Σ^+ and Σ^- physics:

- completes the picture of strangeness production: abundant particles, carry out large fraction of strange quarks;

- possible to compare yields of Σ and Σ^* production, that can be used in study of the QCD phase diagram;

- reconstruction of resonances decaying into Σ;

- reconstruction of hypothetic particles, like H-dibaryon.

Main decay modes:

|		
$\Sigma^+ \rightarrow p\pi^0$	$\bar{\Sigma}^+ \rightarrow \bar{p}\pi^0$	BR = 51.6%
$\Sigma^+ \rightarrow n\pi^+$	$\bar{\Sigma}^+ \rightarrow \bar{n}\pi^-$	BR = 48.3%
$\Sigma^- \rightarrow n\pi^-$	$\bar{\Sigma}^- \rightarrow \bar{n}\pi^-$	BR = 99.8%

The main challenge: at least one neutral daughter in a decay channel

Missing Mass Method

- Σ^+ and Σ^- have only channels with at least one neutral daughter.

- A lifetime is sufficient to be registered by the tracking system: $c\tau = 2.4$ cm for Σ^+ and $c\tau = 4.4$ cm for Σ^-.

- Can not to be identified by the PID detectors.

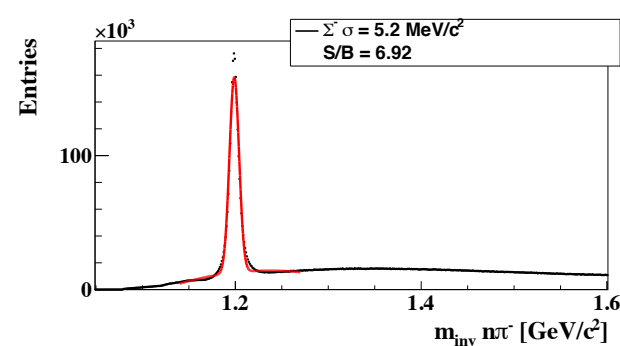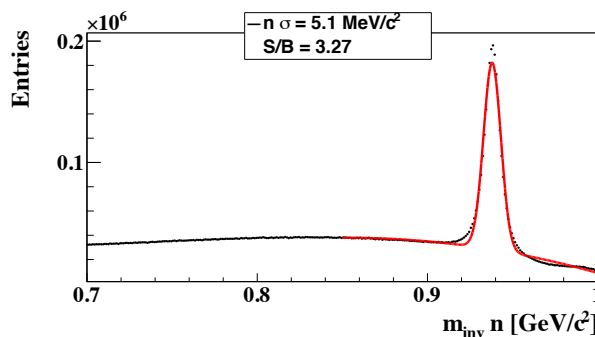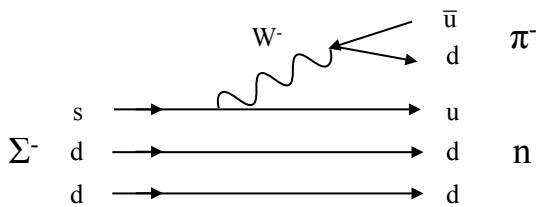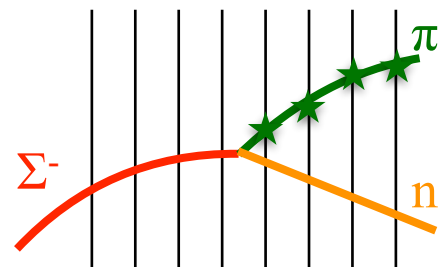- Identification is possible by the decay topology:

Find tracks of Σ and its charged daughter in STS and MVD
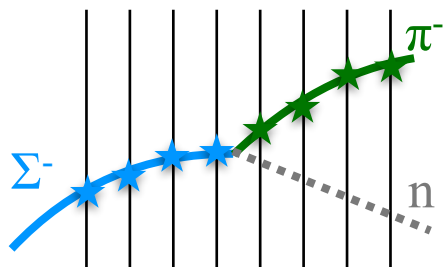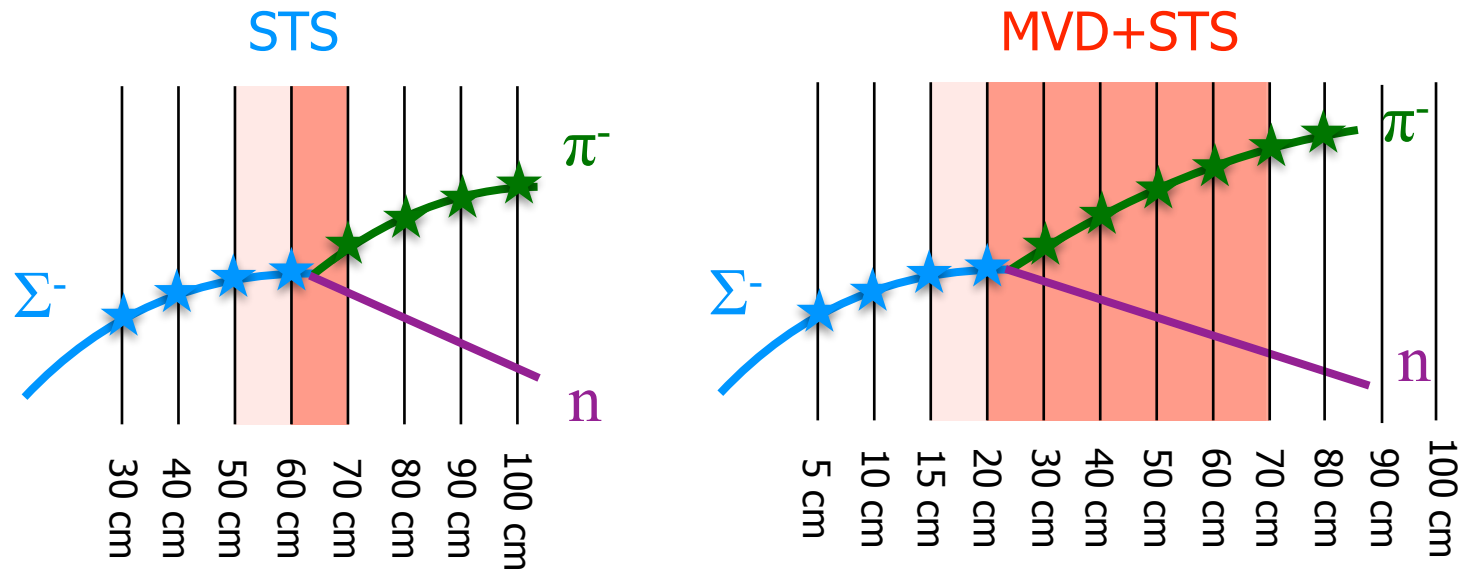
Reconstruct a neutral daughter from the mother and the charged daughter
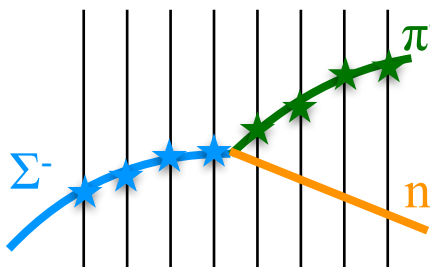
Reconstruct Σ mass spectrum from the charged and obtained neutral daughters
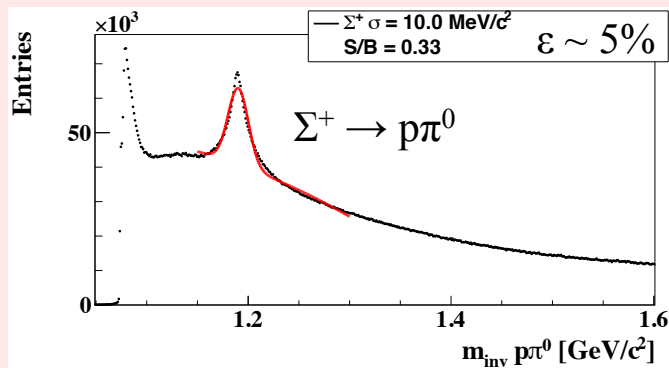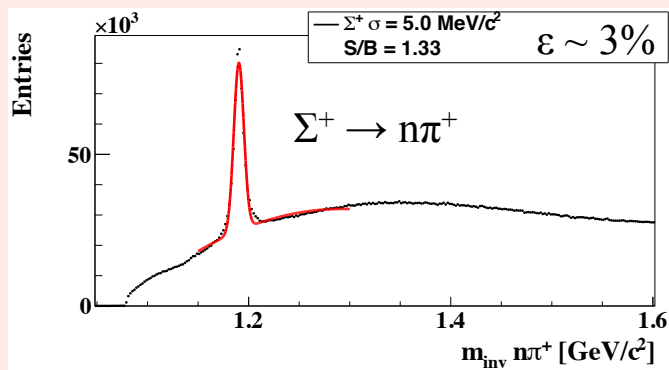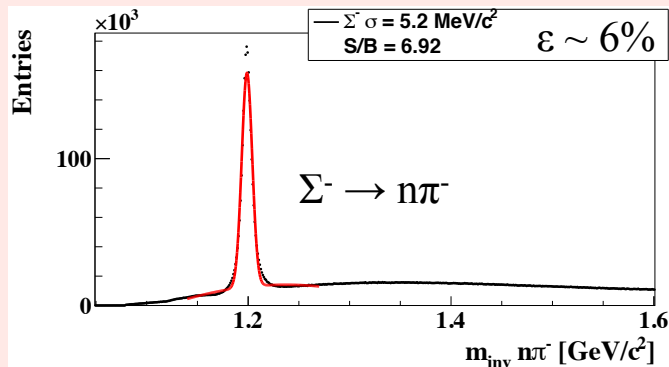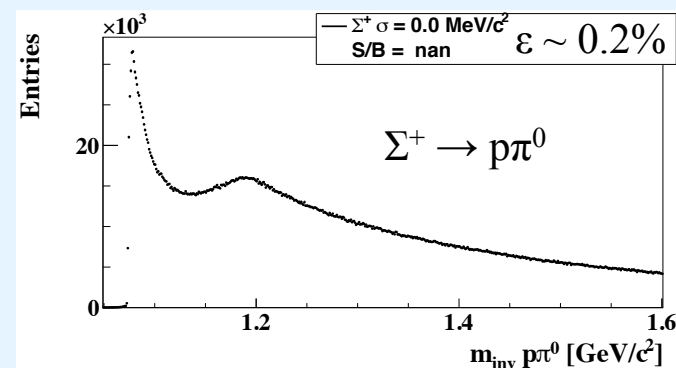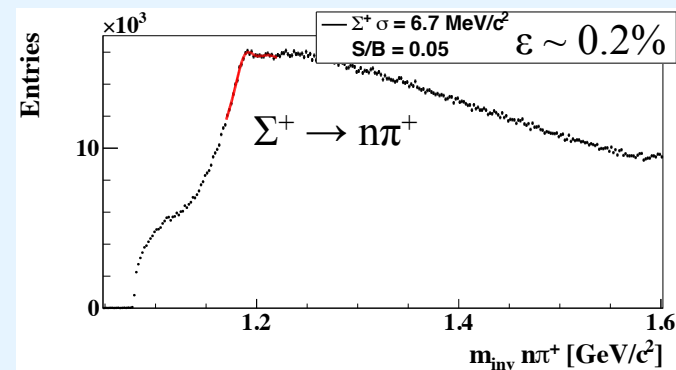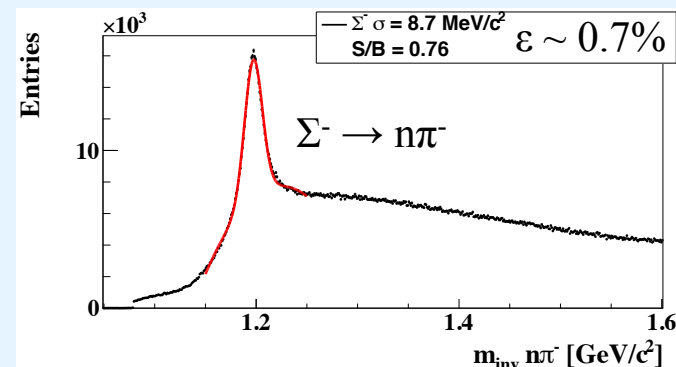
STS

MVD+STS

- The acceptance of STS for Σ^+ and Σ^- is limited by $50 < Z < 70$ cm:
  - the primary Σ track can have 3 or 4 hits;
  - the π^- daughter track should have at least 4 hits.
- MVD allows to increase the acceptance significantly to $15 < Z < 70$ cm.

MVD+STS

STS

5M central UrQMD AuAu events at 10 AGeV, no PID
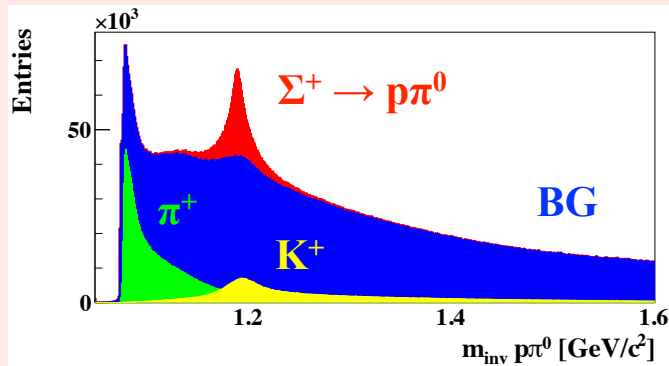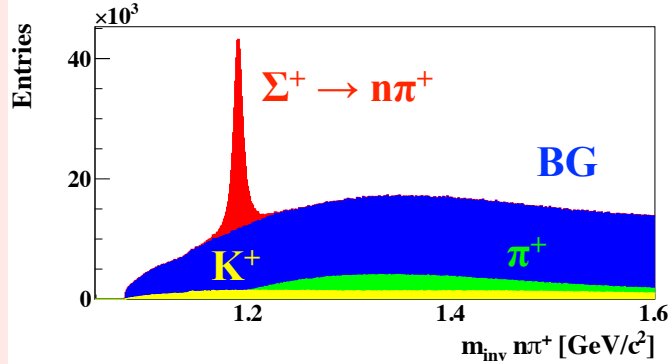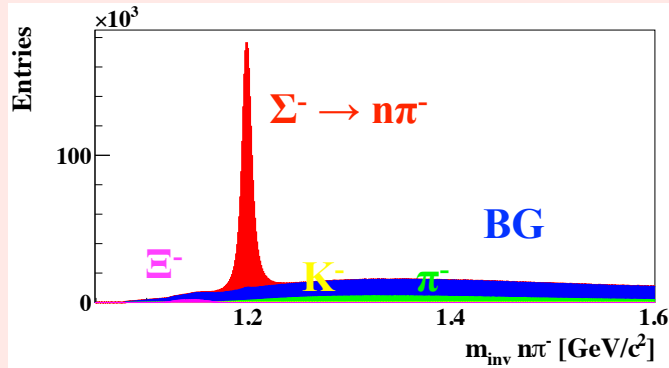
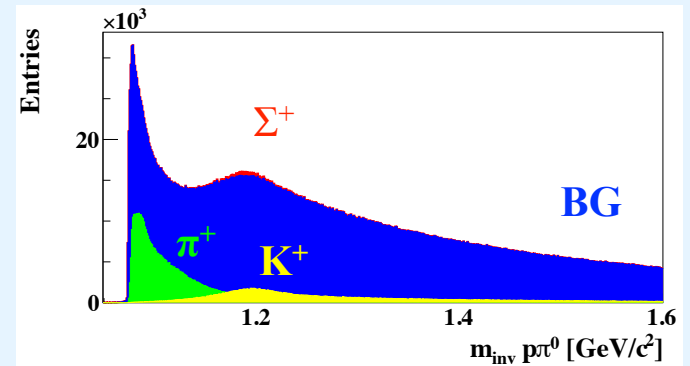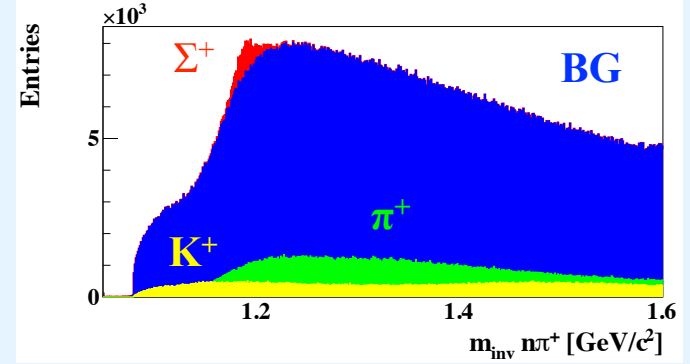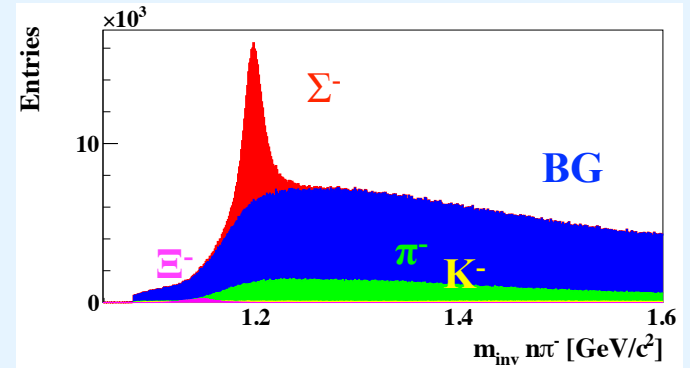The background has a complicated structure and will be further studied

The proposed method can be applied for reconstruction
of multi-strange hyperons:

$\Xi^- \rightarrow \Lambda \pi^-$ with $\Lambda \rightarrow n\pi^0$ BR = 35.6%
$\overline{\Xi}^+ \rightarrow \overline{\Lambda} \pi^+$ with $\overline{\Lambda} \rightarrow \overline{n}\pi^0$ BR = 35.6%
$\Omega^- \rightarrow \Lambda K^-$ with $\Lambda \rightarrow n\pi^0$ BR = 24.3%
$\overline{\Omega}^+ \rightarrow \overline{\Lambda} K^+$ with $\overline{\Lambda} \rightarrow \overline{n}\pi^0$ BR = 24.3%
$\Omega^- \rightarrow \Xi^0 \pi^-$ BR = 23.6%
$\overline{\Omega}^+ \rightarrow \overline{\Xi}^0 \pi^+$ BR = 23.6%

Kaons and Pions:

$\pi^+ \rightarrow \mu^+ \nu_\mu$ BR = 99.99%
$\pi^- \rightarrow \mu^- \overline{\nu}_\mu$ BR = 99.99%
$K^+ \rightarrow \mu^+ \nu_\mu$ BR = 63.6%
$K^- \rightarrow \mu^- \overline{\nu}_\mu$ BR = 63.6%
$K^+ \rightarrow \pi^+ \pi^0$ BR = 20.7%
$K^- \rightarrow \pi^- \pi^0$ BR = 20.7%

These decays are being added to the KF Particle Finder (HK 25.5)

Reconstruction of these decays allows to:
• increase reconstruction efficiency for multi-strange hyperons;
• investigate systematic errors;
• study the background.

Summary

- The method for reconstruction of Σ^+ and Σ^- has been developed, that allows to complete the picture of strangeness production.

- The missing mass method provides a capability to reconstruct Σ^+ and Σ^- with high efficiencies and S/B ratios.

- The method can be applied for reconstruction of other decays including multi-strange hyperons and hypernuclei.

Plans

- Implement all decays in KF Particle Finder.

- Add PID information.