Strange particle reconstruction in the CBM experiment at FAIR

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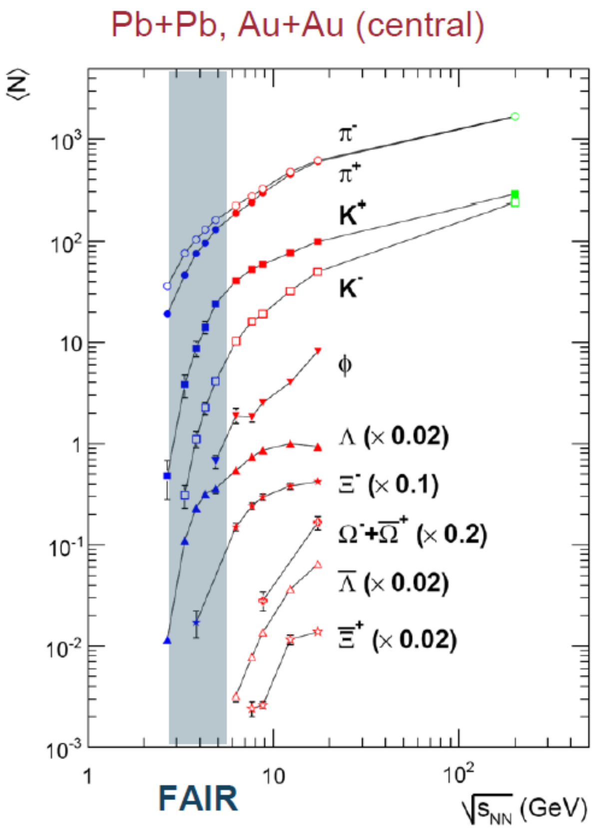
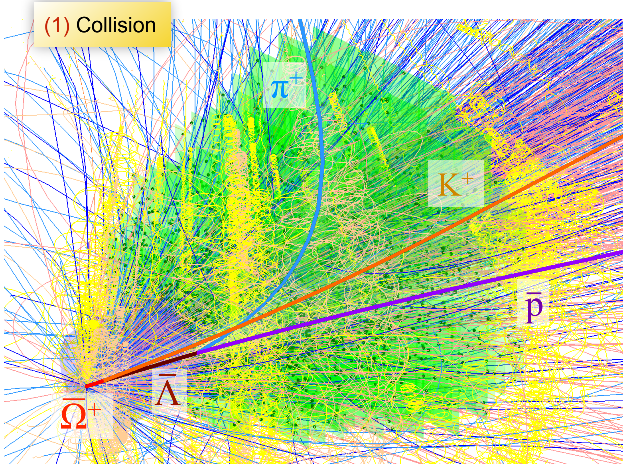
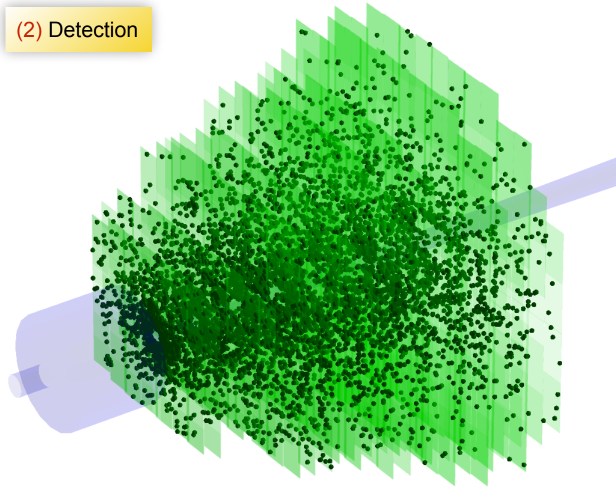
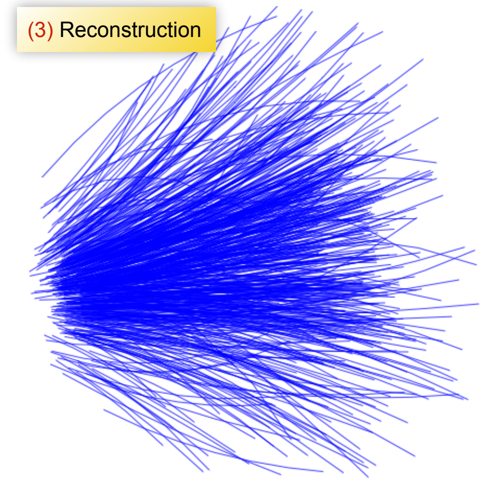


CBM aims to investigate strongly interacting matter in the region high baryonic densities ($\sqrt{s_{NN}}$ = 2.7-4.9 GeV):

- **The equation-of-state at high μ_B**: collective flow of hadrons, particle production at threshold energies: open charm, **multi-strange hyperons**.
- **Deconfinement phase transition at high μ_B**: excitation function and flow of **strangeness (K, Λ, Σ, Ξ, Ω)**.
- **QCD critical endpoint:** excitation function of event-by-event fluctuations (**K/π, Λ/π, Σ/π, Ξ/π, Ω/π…**).
- **Onset of chiral symmetry restoration at high μ_B:** in-medium modifications of hadrons (ρ,ω,φ), excitation function of **multi-strange (anti)hyperons**.





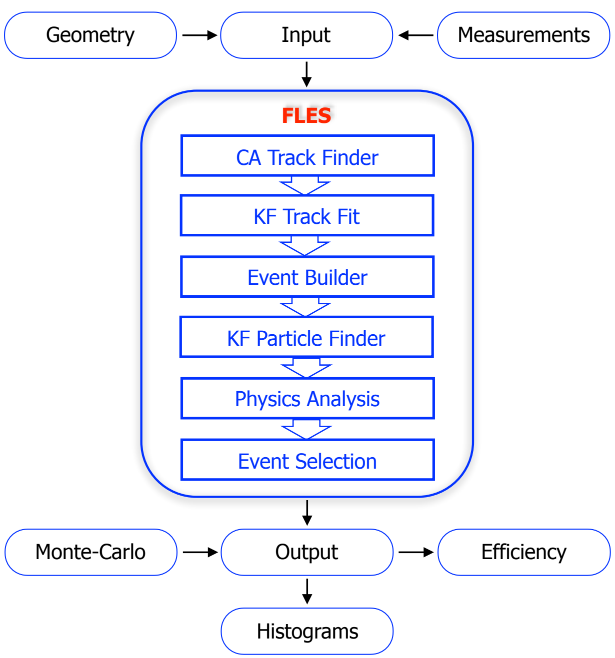


- Future fixed-target heavy-ion experiment at FAIR
- Explore the phase diagram at high net-baryon densities
- 10^7 Au+Au collisions/sec
- ~ 1000 charged particles/collision
- Non-homogeneous magnetic field
- Double-sided strip detectors
- 4D reconstruction of time slices.

The full event reconstruction will be done on-line at the First-Level Event Selection (FLES) and off-line using the same FLES reconstruction package.

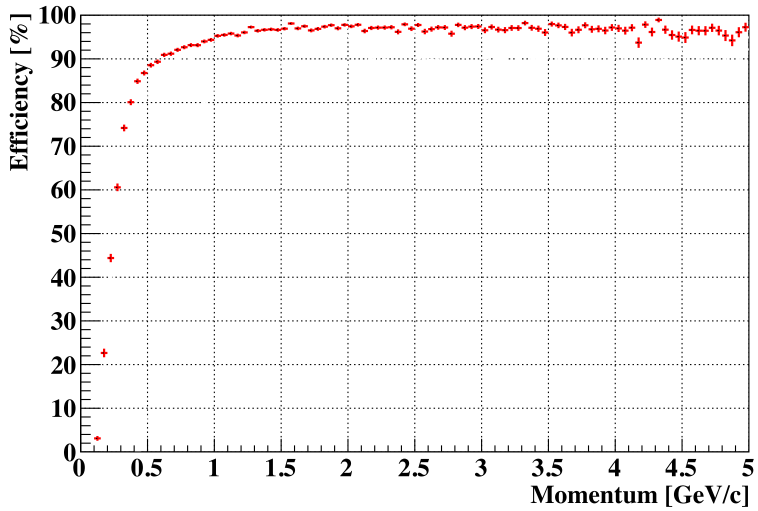
- Cellular Automaton (CA) Track Finder
- Kalman Filter (KF) Track Fitter
- KF short-lived Particle Finder

All reconstruction algorithms are vectorized and parallelized.

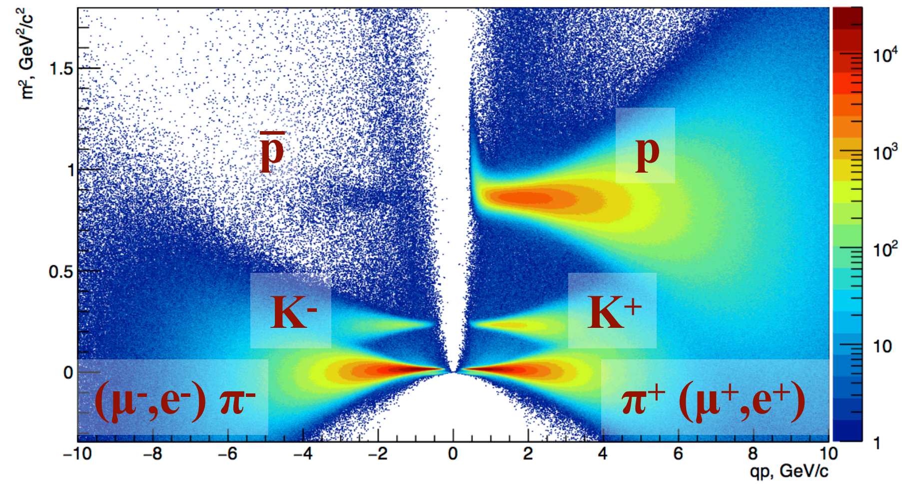


Input for reconstruction of strange particles: tracks and PID

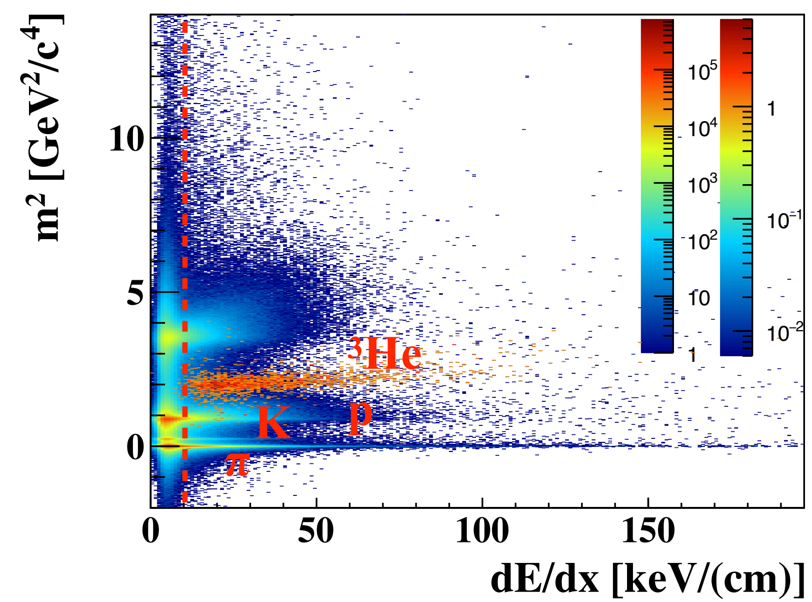
STS and MVD: reconstruction of tracks



ToF: hadron identification



Combined ToF-TRD PID



Track reconstruction:

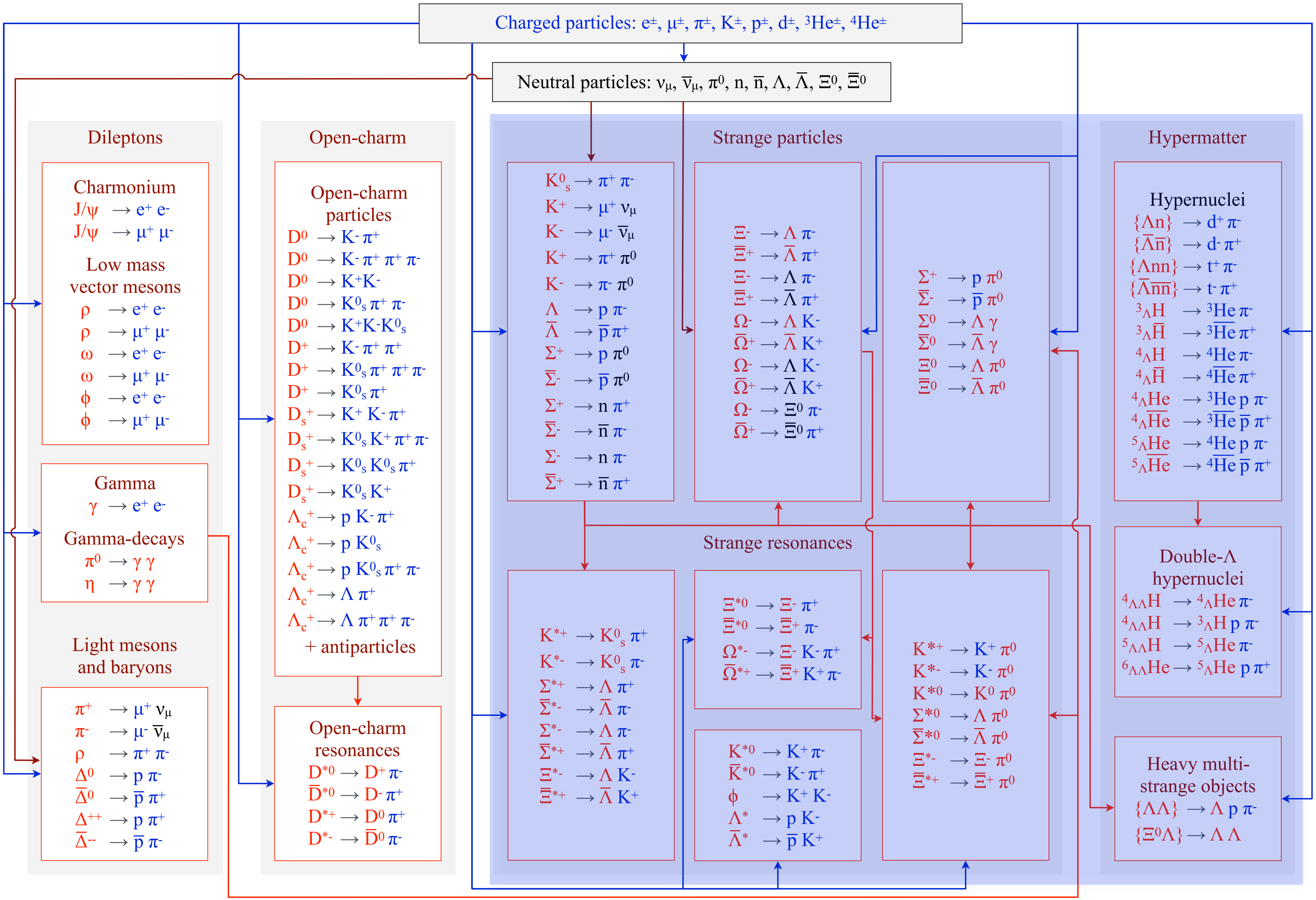
- Cellular automaton for track reconstruction and Kalman filter for track fit (see talk HK 48.2 by Valentina Akishina).

PID for strange particle reconstruction:

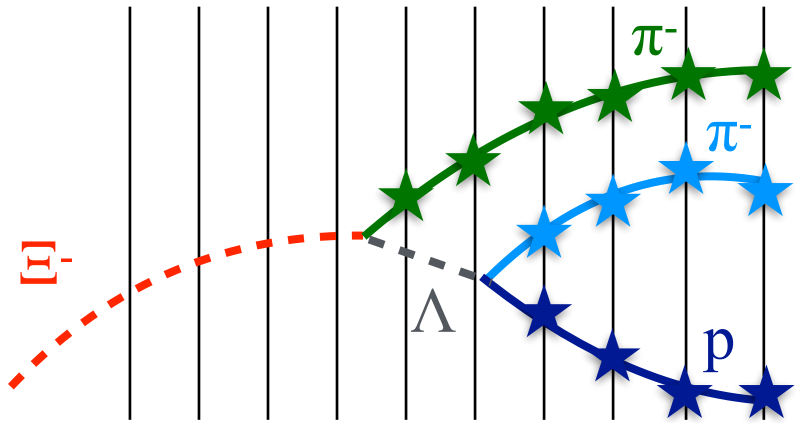
- ToF (Time of Flight) — hadron identification by time of flight.
- TRD (Transition Radiation detector) and STS — identification of heavy fragments by dE/dx method.

CBM will allow reconstruction of tracks with high efficiency and clean identification.

KF Particle Finder: more than 150 decay channels

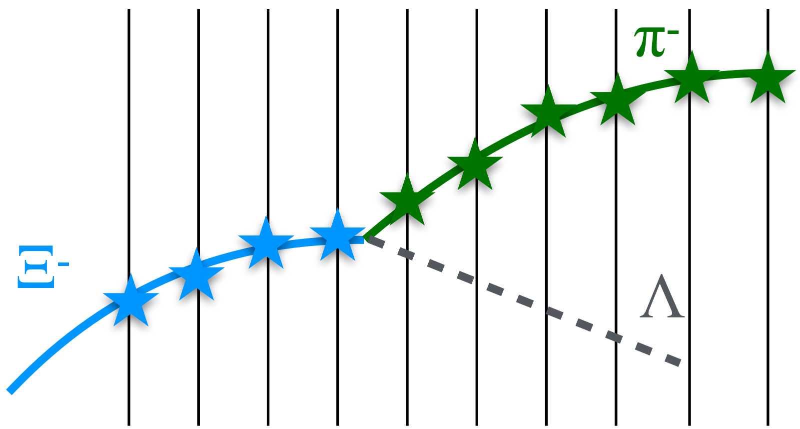


Conventional method



1. Find tracks of charged daughter from mother particle and both charged daughters from neutral particle in STS and MVD.
2. Reconstruct the neutral daughter from its charged daughters.
3. Reconstruct mother particle from the charged and obtained neutral daughters.

Missing mass method



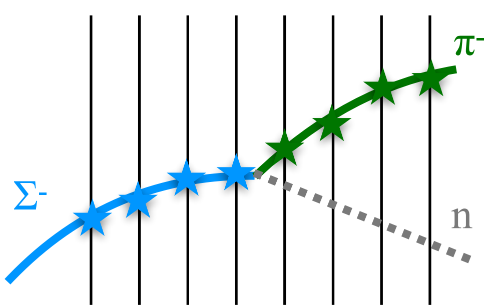
1. Find tracks of mother particle and its charged daughter in STS and MVD.
2. Reconstruct the neutral daughter from the mother and the charged daughter particles.
3. Reconstruct mother particle from the charged and obtained neutral daughters.

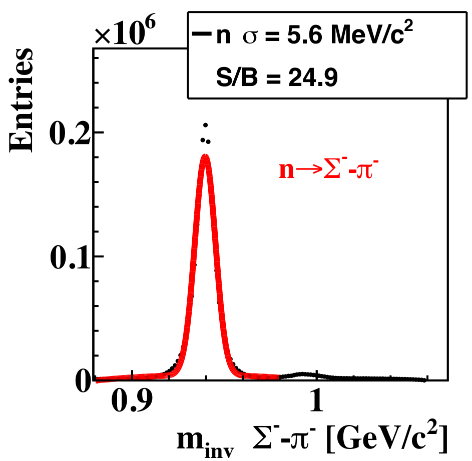
Σ^+ and Σ^- physics: completes the picture of strangeness production: abundant particles, carry out large fraction of strange quarks.

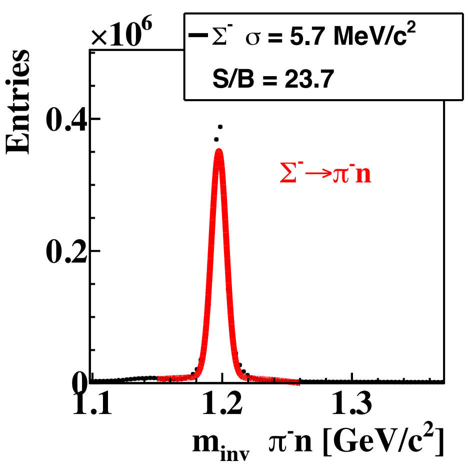
- Σ^+ and Σ^- have only channels with at least one neutral daughter.

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

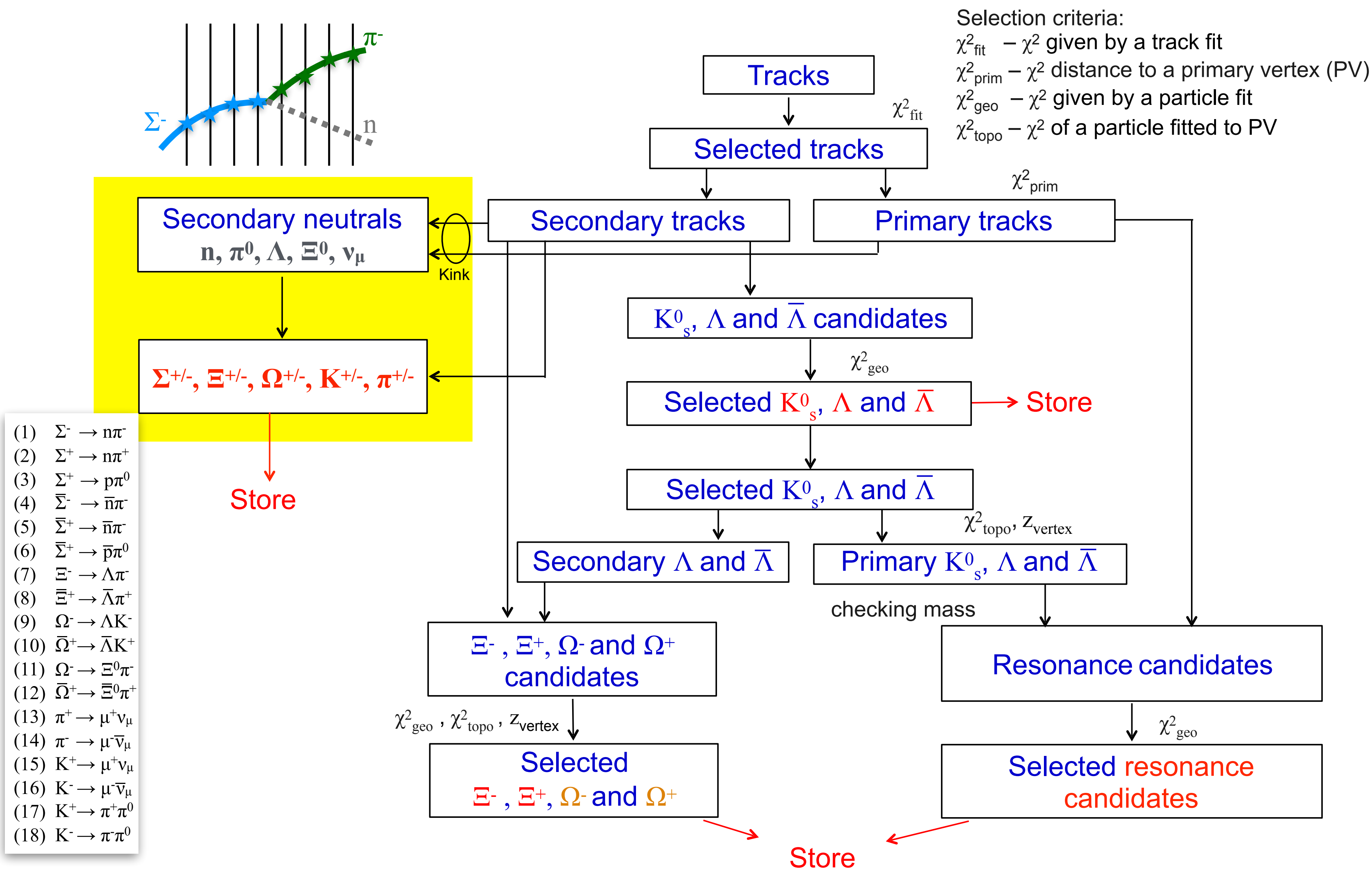
- Lifetime is sufficient to be registered by the tracking system: $c\tau = 2.4$ cm for Σ^+ and $c\tau = 4.4$ cm for Σ^-.
- Can not to be identified by the PID detectors.
- Identification is possible by the decay topology:



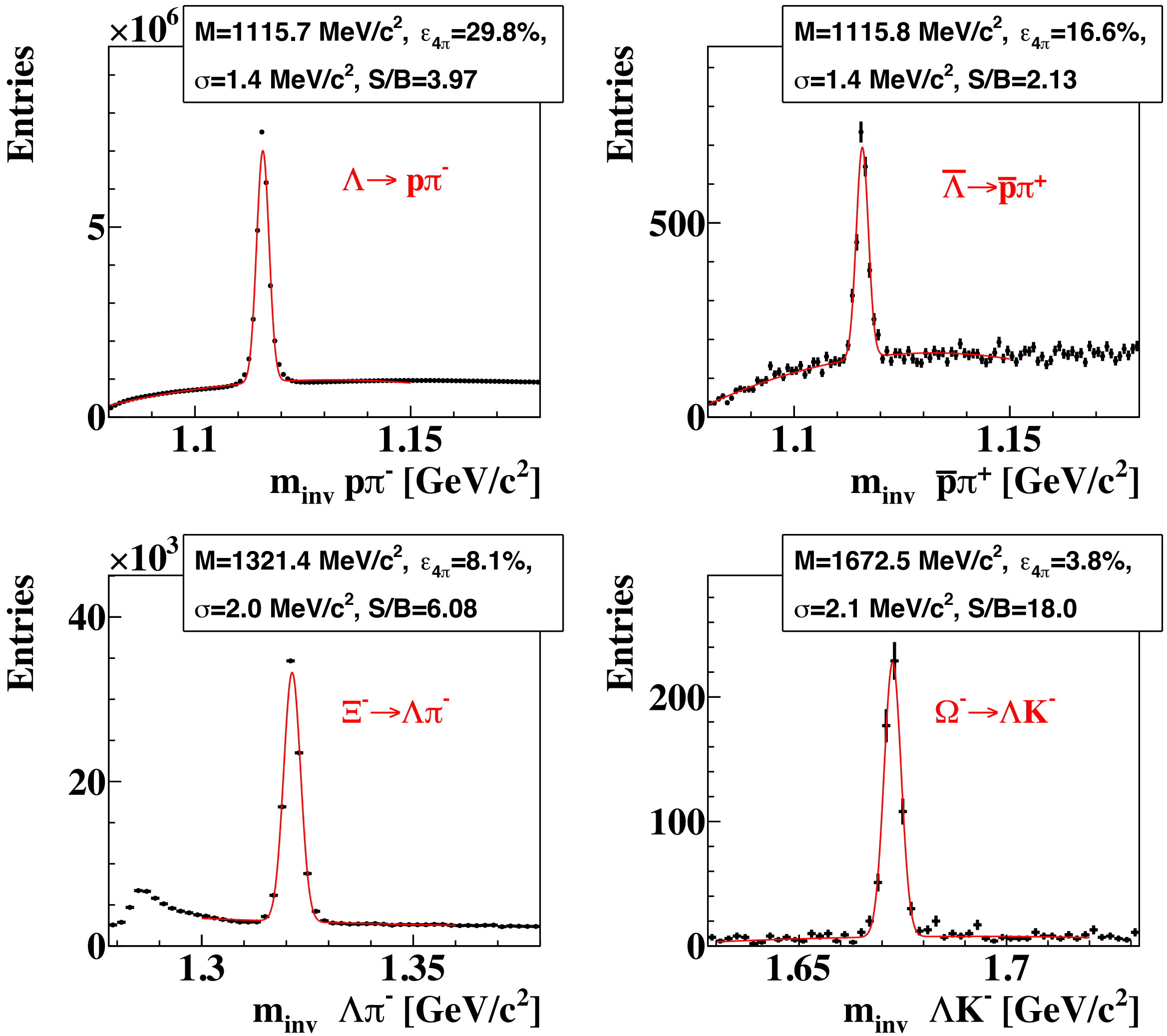




Extended KF Particle Finder Algorithm



5M central AuAu UrQMD events at 10 AGeV

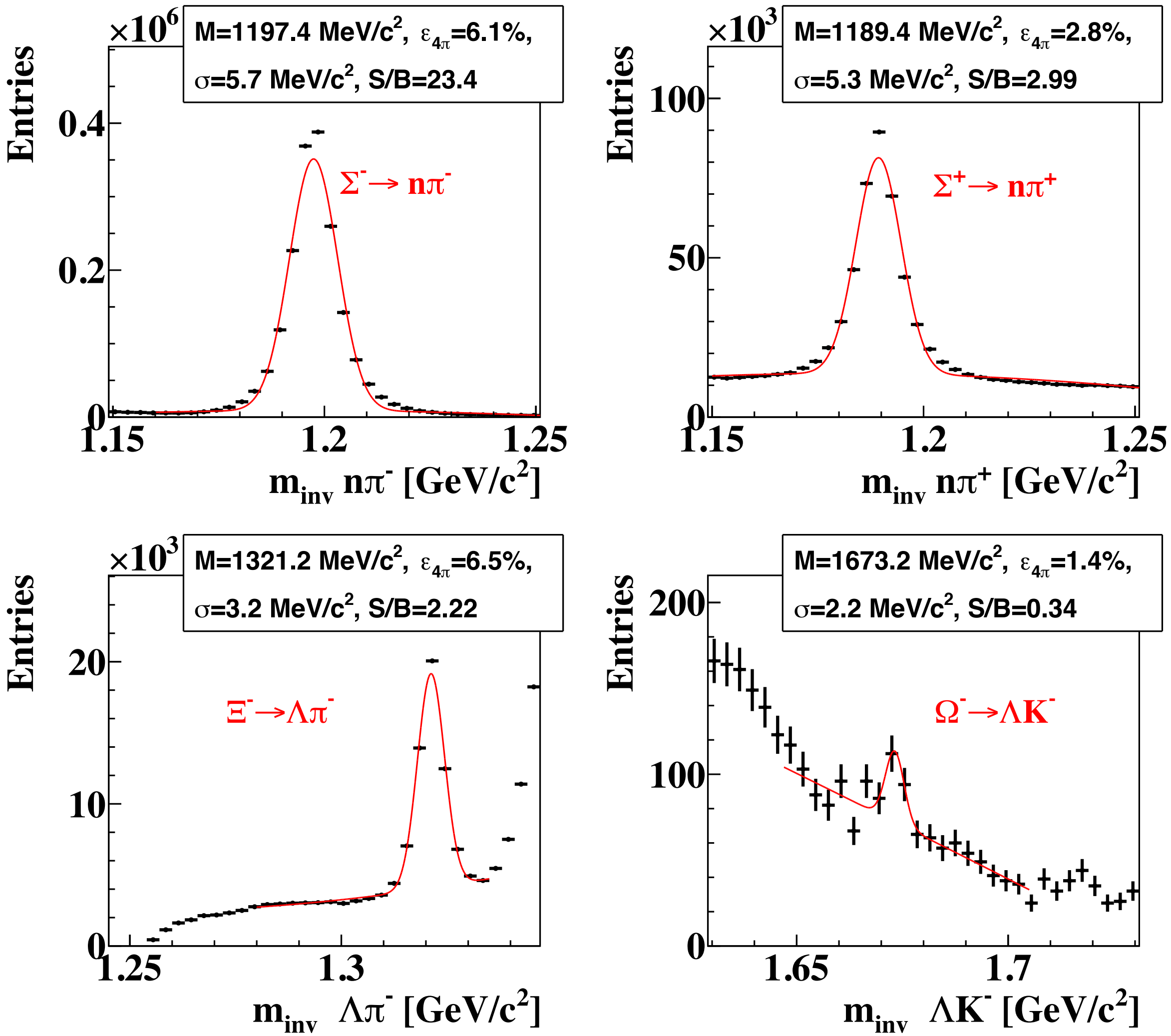


Conventional method

- Is well established and widely used in High Energy and Heavy Ion physics.
- CBM allows clean reconstruction of strange particle spectra.
- High efficiency with high significance and signal to background ratios.
- Σ baryons and multi-strange particles with secondary $\Lambda \rightarrow n\pi^0$(36% BR) are not visible for the method.

Strange particles by the missing mass method

5M central AuAu UrQMD events at 10 AGeV



Missing mass method

In addition to conventional method the missing mass method is used to reconstruct strange particles.

Covers an additional kinematic region.

It opens access to the new physics:

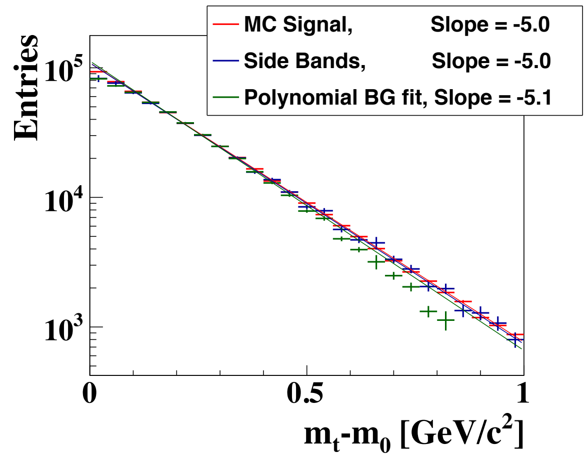
- Σ hyperons;
- resonances with Σ daughter;
- new channels of hypernuclei.

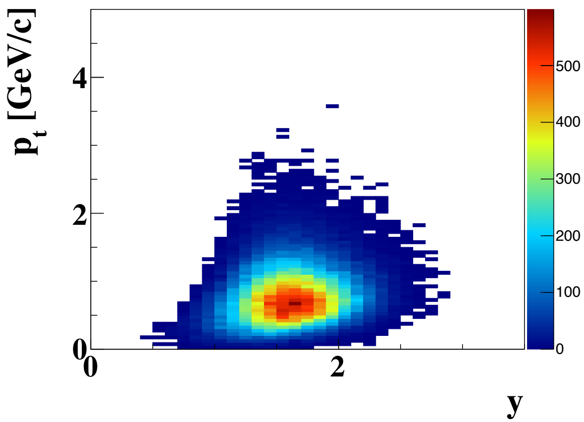
More decay channels can be studied.

Acceptance of the detector for strange particles is increased in this case.

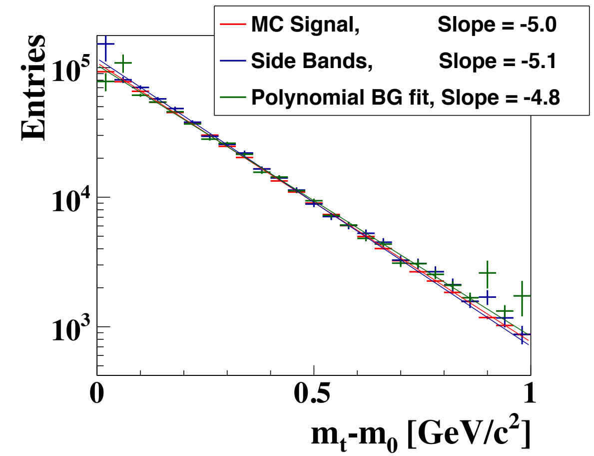
Reconstruction of Ξ^- spectra

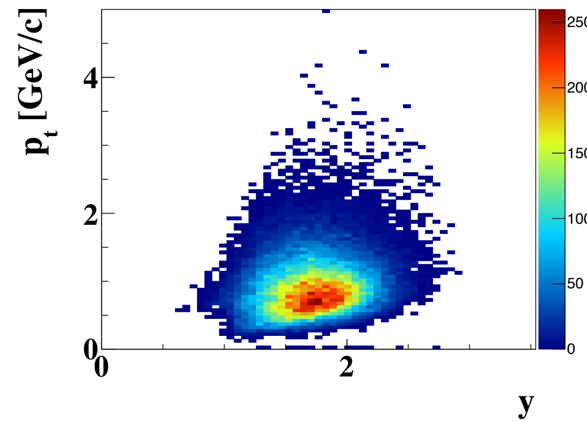
Conventional method





Missing mass method





5M central AuAu UrQMD events at 10 AGeV

- Efficiency corrected m_t spectra and reconstructed signal in y-p_t showing acceptance.
- Results are comparable.
- Methods cover different kinematic regions.
- Two independent methods provide a powerful tool for systematics study.

Summary and Plans

✓ The CBM detector system is well suitable for comprehensive study of such observables as strange and multi-strange hyperons, resonances and hypernuclei including extremely rare particles.

✓ Two independent approaches for reconstruction of strange particles are developed and implemented in CBM based on the conventional and missing mass methods.

✓ The missing mass method gives a unique possibility to study Σ physics and thus to complete the picture of strangeness production.

✓ The missing mass method allows to cover an additional kinetic region and decay channels not visible for the conventional method, such as $\Xi^- \to \pi^-(\Lambda \to n\pi^0)$, $\Omega^- \to K^-(\Lambda \to n\pi^0)$.

✓ Both methods show high efficiency, significance and S/B rations. The results are comparable and can be used for systematic studies.

- Add and investigate new channels such as
  - resonances with Σ daughter,
  - hypernuclei with neutral daughter.
- Study of systematic errors of the methods.