Multi-differential analysis with KF Particle Finder in the CBM experiment
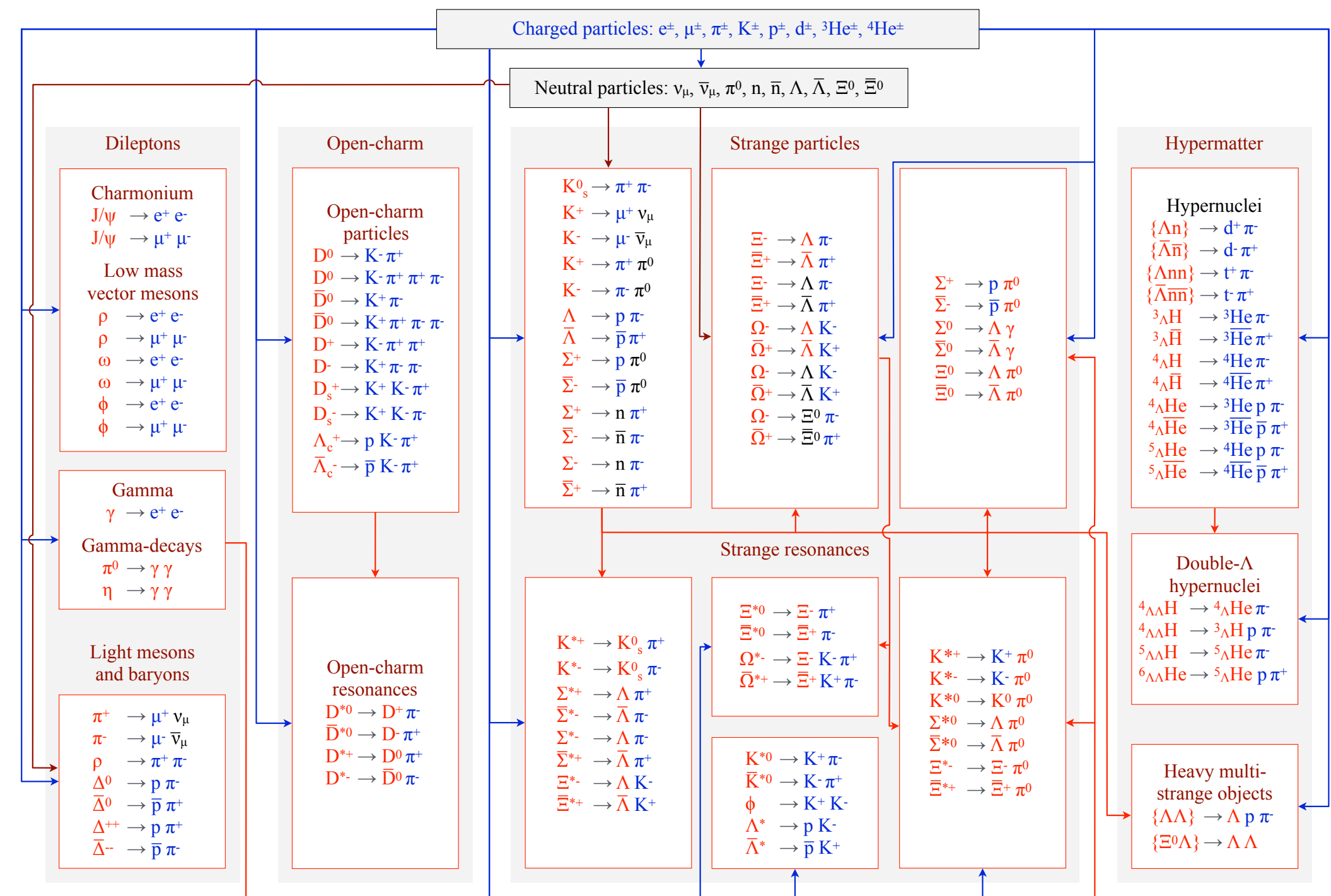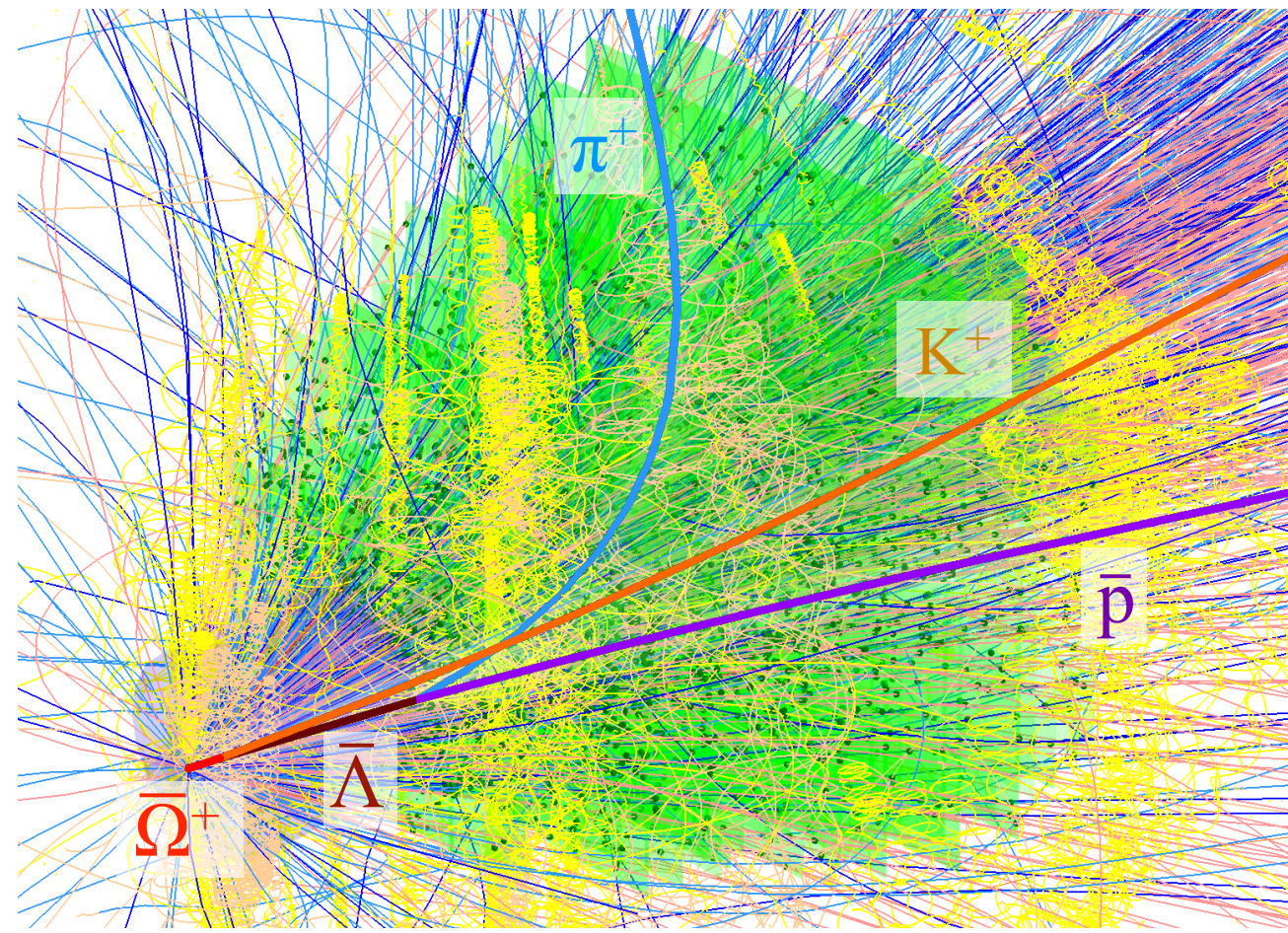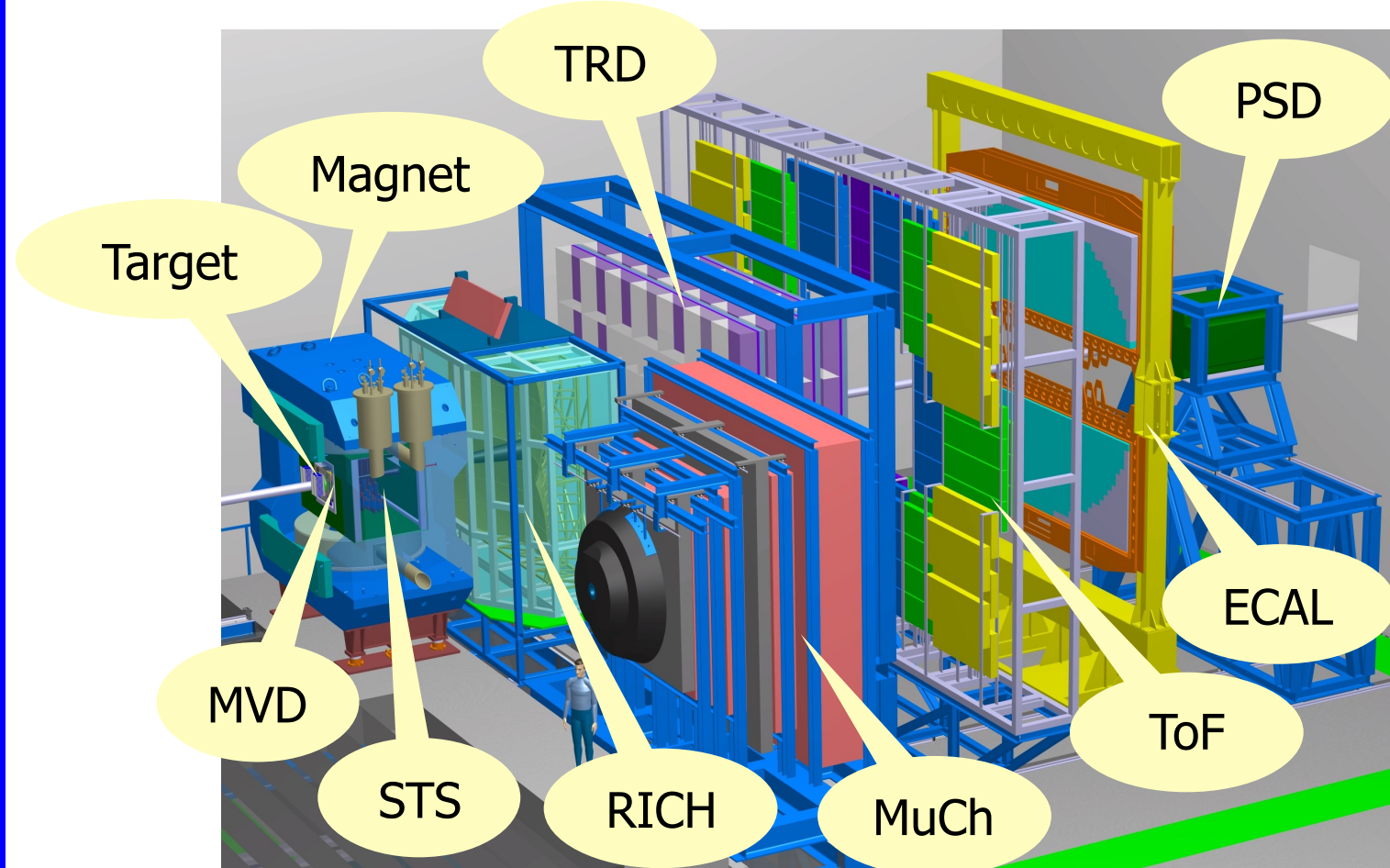
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CBM

Compressed Baryonic Matter experiment at FAIR

Reconstruction challenge in the CBM Experiment


- CBM — future fixed-target heavy-ion experiment at FAIR, Darmstadt, Germany.
- 10^5–10^7 collisions per second.
- Up to 1000 charged particles/collision.
- Free streaming data.
- No hardware triggers.
- On-line event reconstruction and selection is required in the first trigger level.

- On-line reconstruction at the on-line farm with 60000 CPU equivalent cores.
- High speed and efficiency of the reconstruction algorithms are required.
- The algorithms have to be highly parallelised and scalable.
- CBM event reconstruction: Kalman Filter and Cellular Automaton.

- KF Particle Finder includes more than 100 decays, uses Kalman filter mathematics, geometry independent.
- Searches for short-lived particles combining tracks and reconstructed particles according to the PID hypothesis.
- The package is highly optimised and vectorised.

Methods for obtaining signal spectra

Side bands method

Polynomial background fit
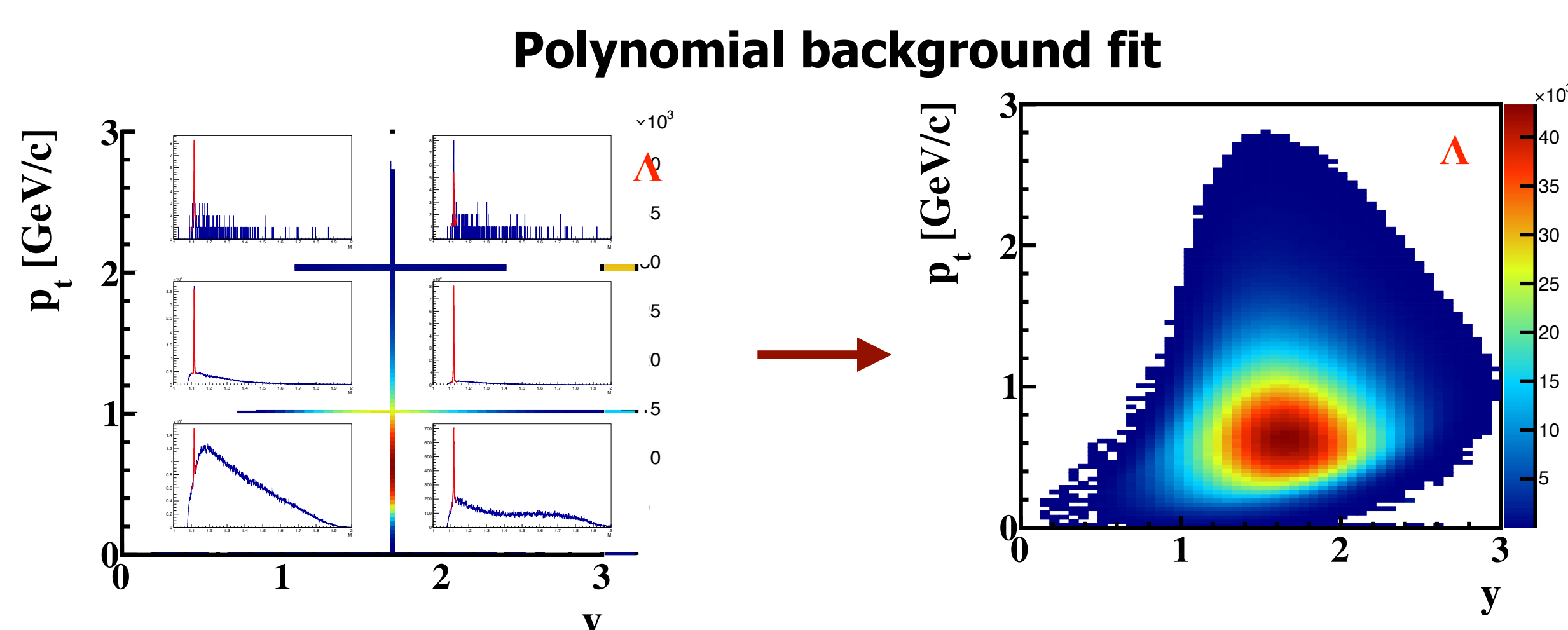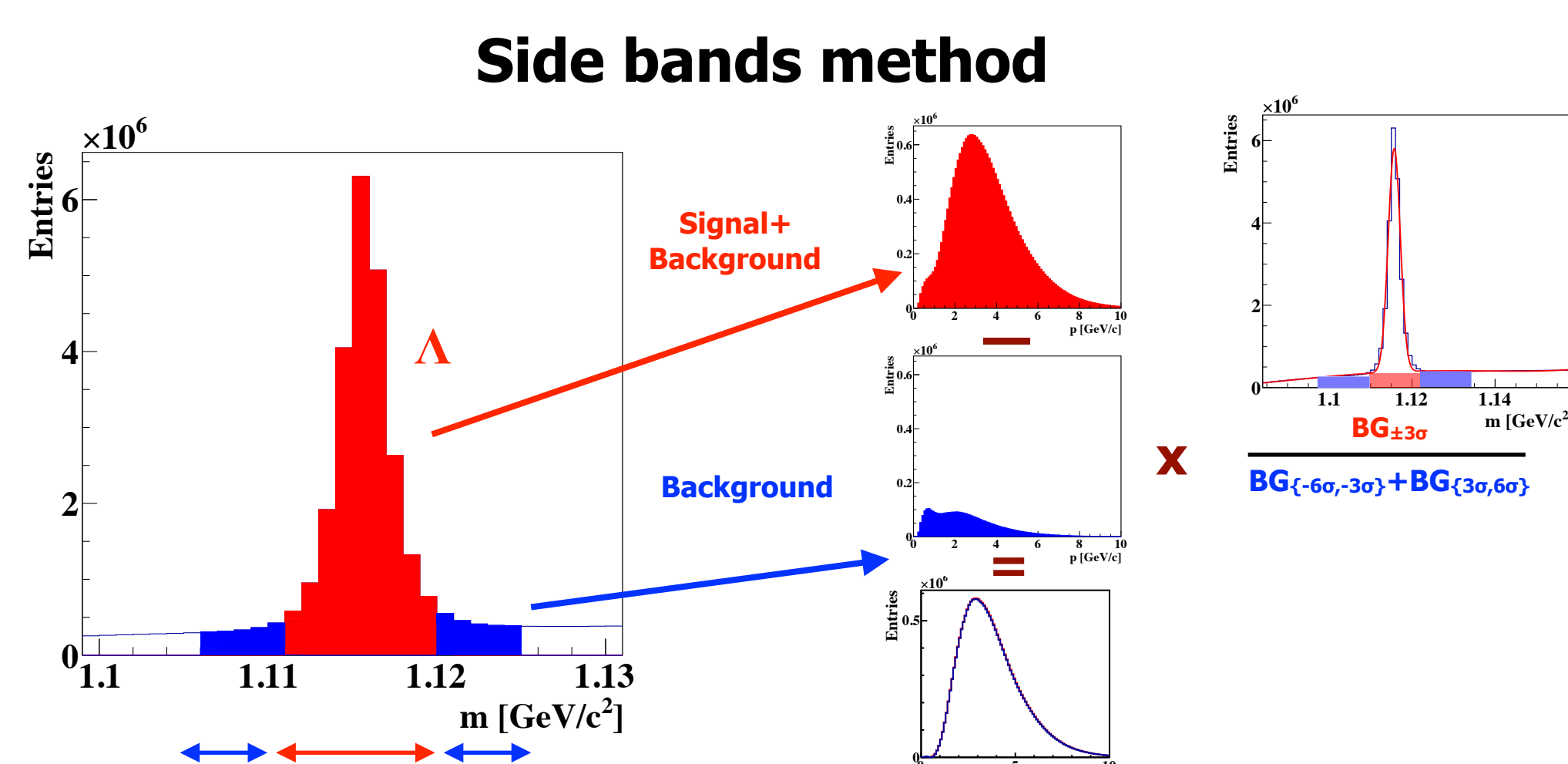
- Collect spectra (M, p, p_t, y, Z...) for the signal+BG (particles with the reconstructed mass within the mass peak) and BG (particles near the peak).
- Calculate the correction factor using the fitted BG.
- Subtract the corrected BG.

- Collect mass spectra in different y-p_t bins.
- Fit spectra with a signal+background function — calculate an integral of the signal.
- Fill bins of the y-p_t histogram with the integral values — obtain the y-p_t distribution for the signal particles.

Reconstructed signal spectra

$K^0_s \rightarrow \pi^+\pi^-$

Raw — Efficiency corrected — Reconstruction efficiency

$\Xi^- \rightarrow \Lambda\pi^-$
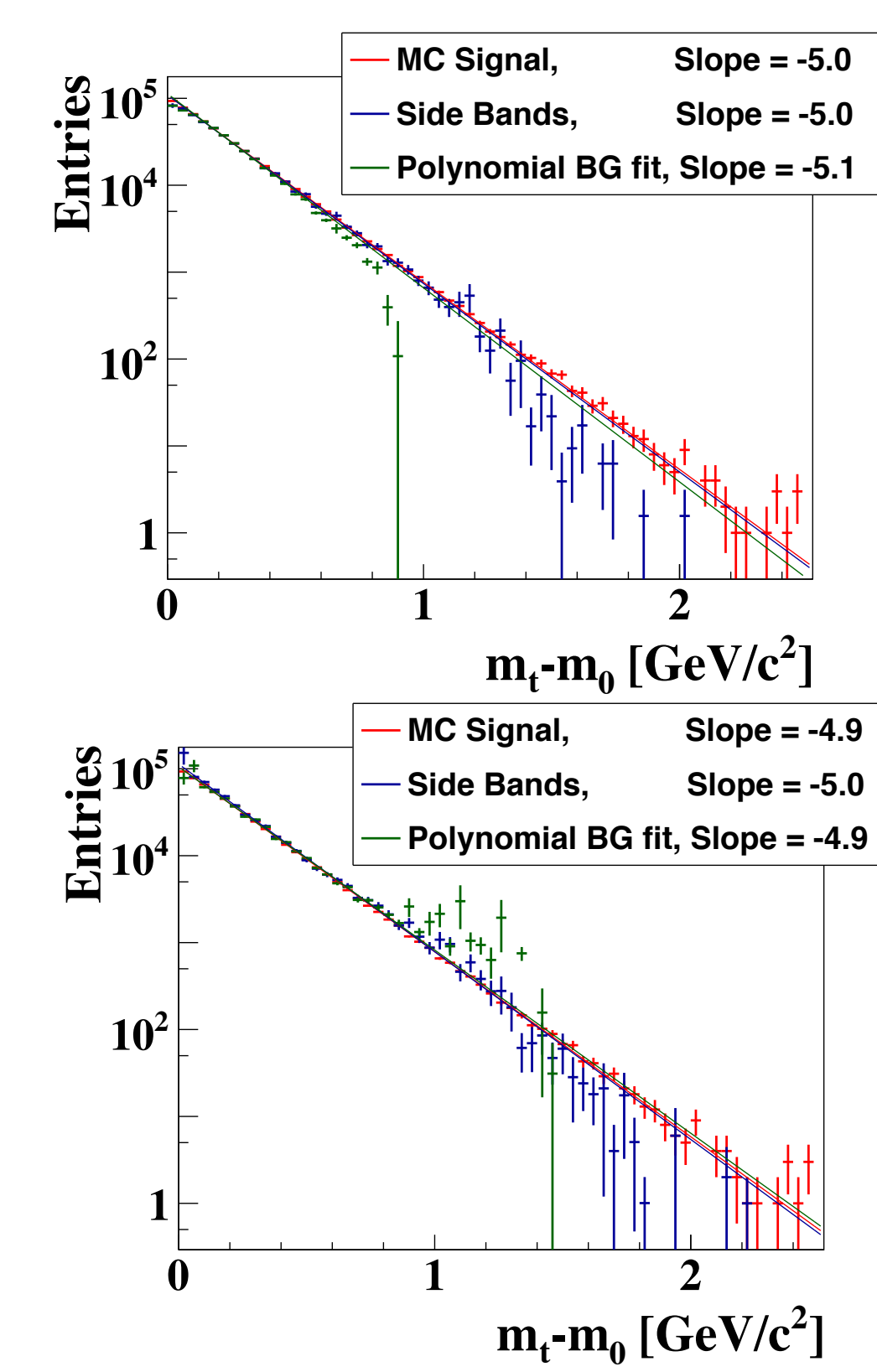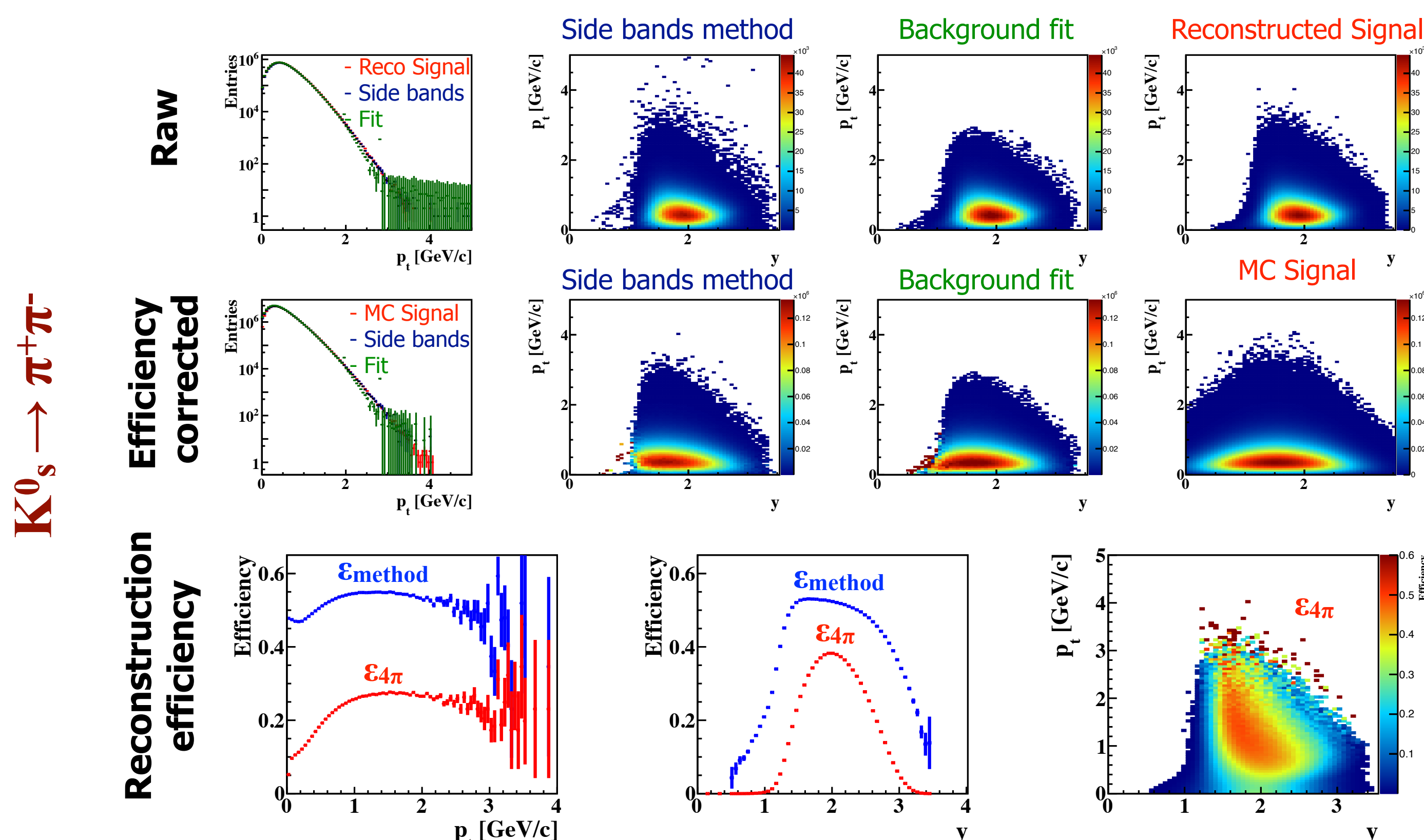
Conventional:
- all daughter tracks are found
- the full decay tree is reconstructed

Missing mass:
- Ξ^- and π^- tracks are found
- neutral daughter is reconstructed from Ξ^- and π^- tracks:
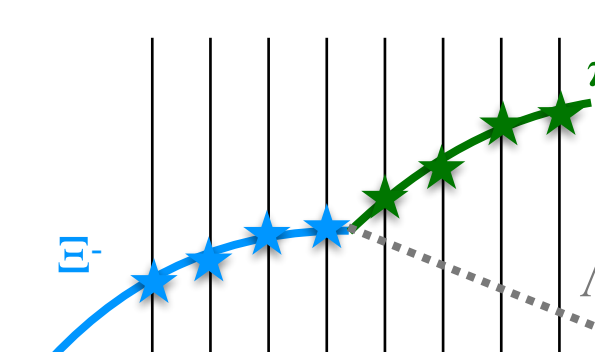
5M central AuAu UrQMD events at 10 AGeV

- Implemented methods allow to extract signal spectra with high precision and efficiency.
- The KF Particle Finder package contains tools for calculation of the reconstruction efficiency including multi-dimensional.
- KF Particle Finder provides perfect tools for physics analysis and systematic studies.

Conclusions

✓ KF Particle package provides rich functionality for reconstruction of short-lived particles.

✓ Use of the Kalman filter method provides accurate and mathematically correct procedures for reconstruction of particles with high precision and efficiency.

✓ Two methods for reconstruction of the signal spectra are added to the package, that provides a powerful tool for systematics studies.

✓ The package allows correct calculation of the reconstruction efficiencies.

✓ KF Particle Finder is highly optimised and vectorised for fast online operation.

✓ The KF Particle Finder package is geometry independent, that makes it a universal platform for short-lived particles reconstruction and physics analysis in High Energy Physics experiments.