Time-based particle reconstruction and event selection in the CBM experiment

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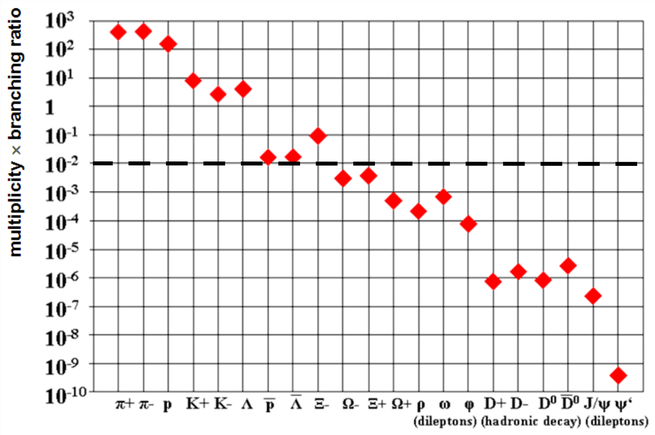
(for the CBM Collaboration)

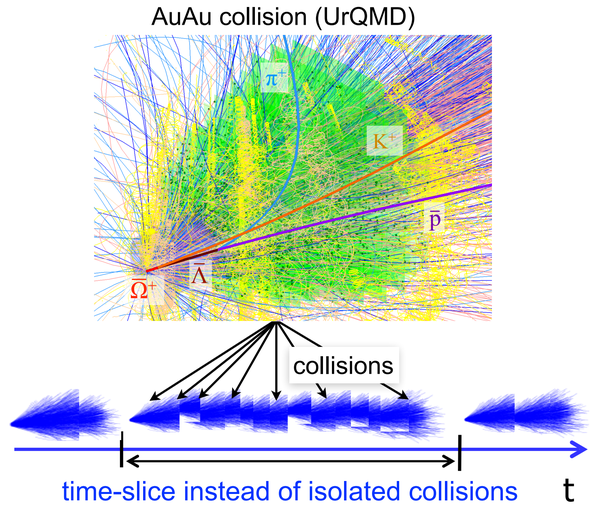
CBM

Compressed Baryonic Matter experiment at FAIR

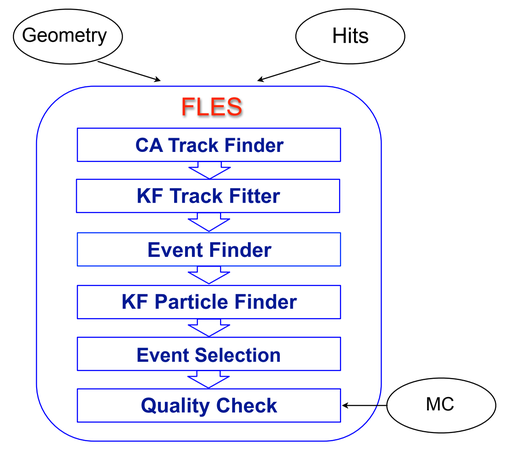
Novel Data-processing Concept of CBM



- CBM is the future fixed-target heavy-ion experiment at FAIR.
- Observables include extremely rare probes (e.g. one $\bar{\Omega}^+$ per 10^6 collisions).
- Unprecedented rates of 10^5-10^7 collisions per second with up to 1000 charged particles are required for sufficient statistics in measurements.
- Observables have complex signatures, no simple hardware triggers.



- Free streaming data.
- Continuous time-slices instead of individual collisions.
- On-line time-based collision reconstruction and selection is required in the first trigger level.

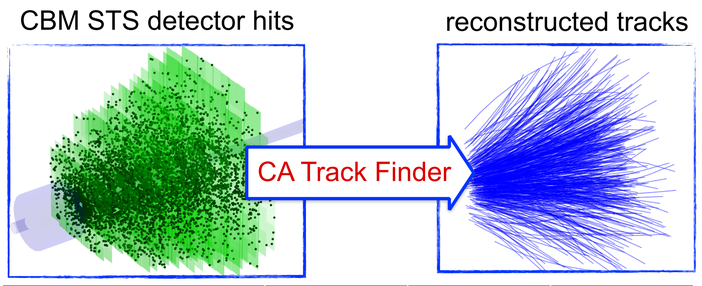


- Cellular Automaton track finder for track search in the Silicon Tracking System (STS).
- Kalman filter based track fitter for track parameters estimation.
- Event Finder based on the obtained set of tracks.
- KF Particle Finder for short-lived particles reconstruction and physics analysis.
- Module for a quality check.

Rare probe measurements require novel data-processing concept.

First Level Event Selection Package (FLES)

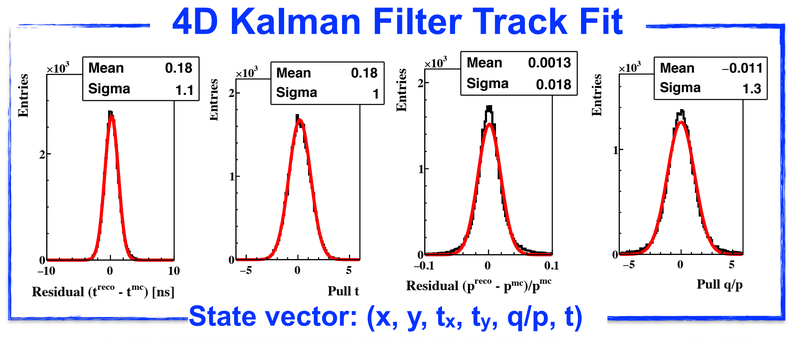
4D Cellular Automaton Track Finder

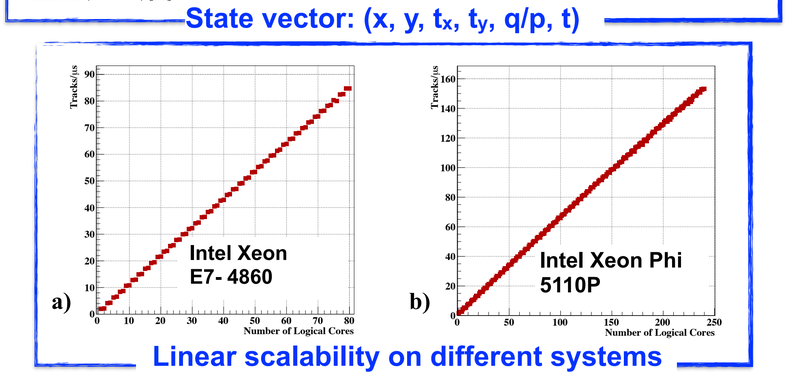


Efficiency, %	3D	0.1 MHz	10 MHz
All tracks	92.5	93.8	91.7
Ghost level	1.8	0.6	0.6
Time, ms/ev	11.70	11.97	13.60

- efficient and stable track reconstruction;
- vectorised and parallel algorithm;
- linear scalability on parallel computer systems;
- time-based performance comparable with event-based analysis;
- 4D tracking is able to recover speed and efficiencies of event-based analysis.

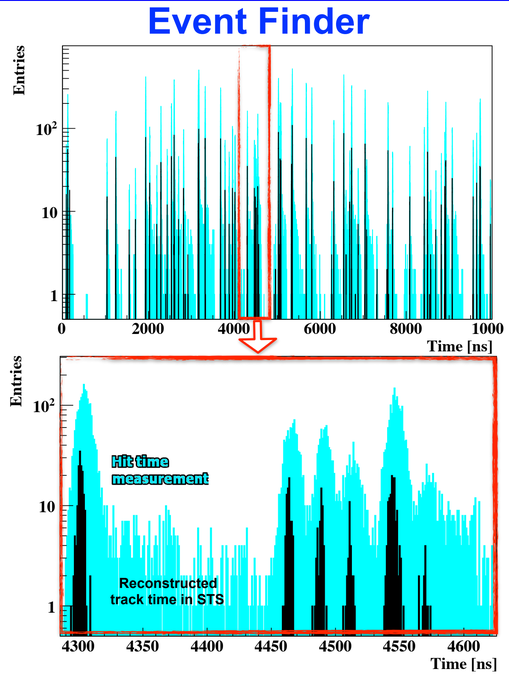
4D Kalman Filter Track Fit





- unbiased track parameters with a high resolution;
- correctly estimated errors;
- strong scalability on various computer systems;

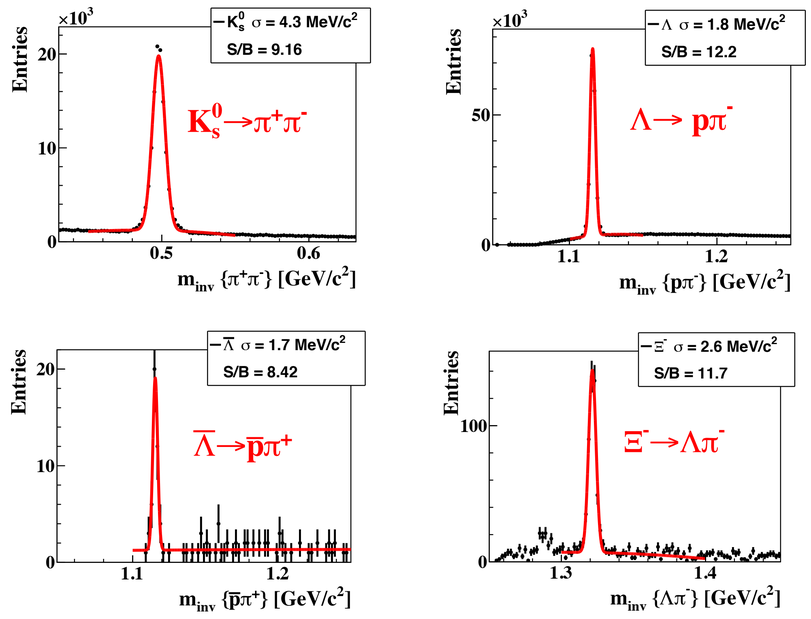
Event Finder



- tracks are split into collision-corresponding groups based on the evaluated time;
- adding all sub-detectors information is in progress;

Parallel and SIMD-ised algorithm allows for timeslice-based reconstruction

Strange Particle Reconstruction in Time-slices



300k mbias AuAu 10 AGeV events at 10 MHz, MC PID

Case	3D	10 MHz
K^0_s, %	22.9	21.2
Λ, %	21.9	19.6
Ξ^-, %	7.8	6.3

KF Particle Finder

- short-lived particles are of particular physics interest;
- particles are reconstructed via decay products;
- events from event finder serve as input for KF Particle Finder;
- time-based reconstruction performance is comparable to the event-based procedure;
- Monte-Carlo particle identification is currently used;
- work in progress: multi-vertex analysis and all detector sub-systems.

Conclusions

- The FLES package is efficient, fast and is highly parallelized both on the data and task levels.
- The reconstruction chain of CBM is being developed capable of the free-streaming data processing.
- It allows to reconstruct individual events out of continuous time-stamped data.
- Reconstructed individual collisions serve as an input for the high-level physics analysis.
- The performance of time-based chain is comparable with event-based analysis.

4D reconstruction performance shows that results of event-based feasability studies are valid.

FAIR CBM GOETHE UNIVERSITÄT FRANKFURT AM MAIN FIAS Frankfurt Institute for Advanced Studies Bundesministerium für Bildung und Forschung HGS-HIRe for FAIR Helmholtz Graduate School for Hadron and Ion Research HIC for FAIR Helmholtz International Center HESSEN GSI