Investigation of Many-Core Scalability of the Track Reconstruction in the CBM Experiment

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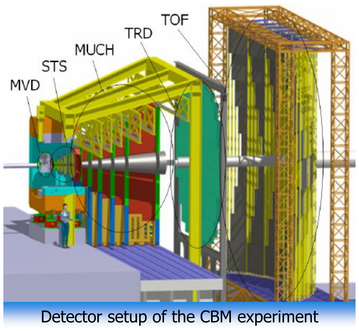
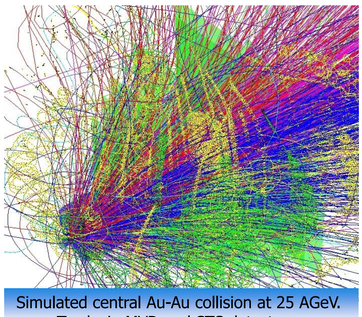
CBM experiment

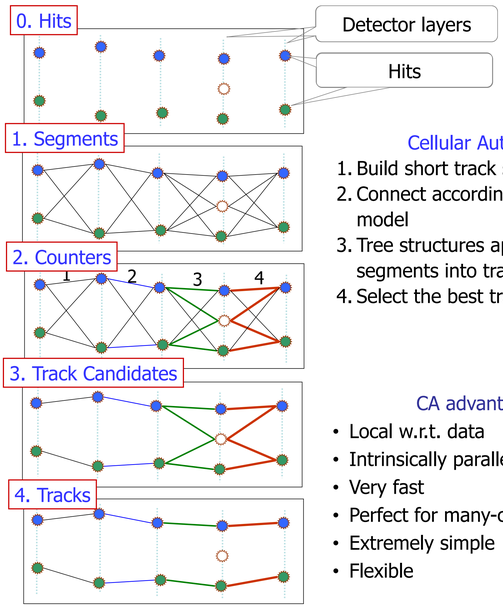


Detector setup of the CBM experiment

- Fixed-target heavy-ion experiment
- 1000 charged particles/collision
- Non-homogeneous magnetic field
- 85% fake combinatorial space points in STS
- 10^7 events/s
- Track reconstruction and displaced vertex search required in the first trigger level


Simulated central Au-Au collision at 25 AGeV. Tracks in MVD and STS detectors.

Cellular Automaton (CA) Track Finder

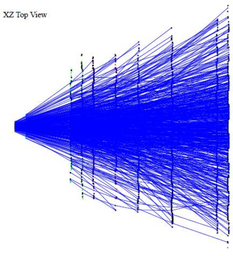


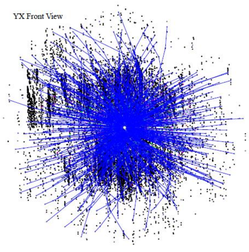
Cellular Automaton:

1. Build short track segments
2. Connect according to the track model
3. Tree structures appear, collect segments into track candidates
4. Select the best track candidates

CA advantages:

- Local w.r.t. data
- Intrinsically parallel
- Very fast
- Perfect for many-core CPU/GPU
- Extremely simple
- Flexible

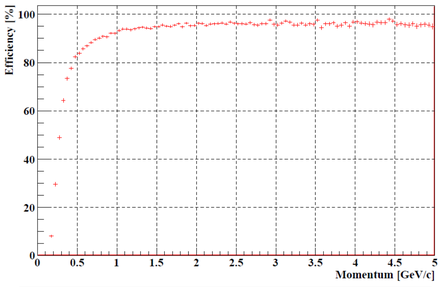




- Takes into account the detector inefficiency
- Highly optimized code
  - Single precision calculations
  - Magnetic field approximation
  - Reconstruction in several iterations
- Highly parallelized code
  - Data level (SIMD instructions, 4 single-precision floating point calculations in parallel)
  - Task level (ITBB, parallelization between cores)

Track Reconstruction Quality

Minimum bias events



Efficiency and ratios, %	
Ref Primary set	97.4
All set	88.1
Clone	0.3
Ghost	1.6
Tracks/ev	153
Time*/ev, ms	25

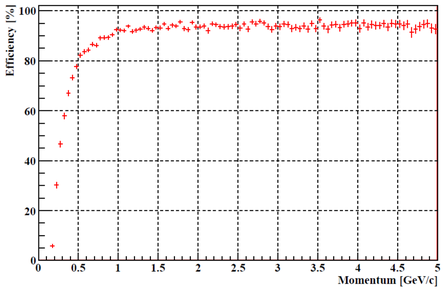
*time using 1 core of cuda.jinr.ru

- high reconstruction efficiency
- with low ghost ratio
- very high speed

Tracks are divided into several caterogies:
All set: p ≥ 0.1 GeV/c
Reference (Ref) set: p ≥ 1 GeV/c
Ghost: purity < 70%

Reconstructable track:
Number of consecutive MC points ≥ 4

Central events

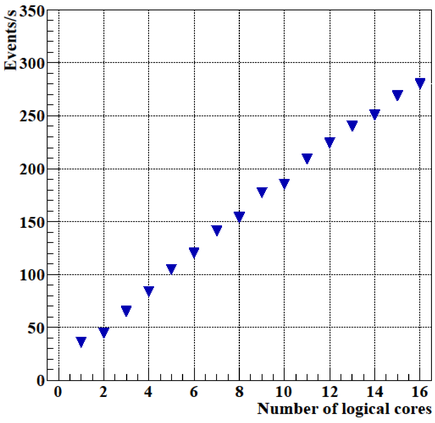


Efficiency and ratios, %	
Ref Primary set	95.5
All set	86.7
Clone	0.4
Ghost	4.4
Tracks/ev	717
Time*/ev, ms	220

Au+Au events at 25 AGeV, 8 STS, geometry with 0 & 15 strip angles.

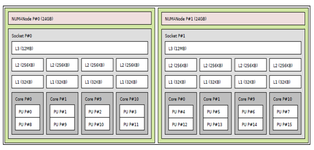
Many-Core Scalability

Minimum bias events

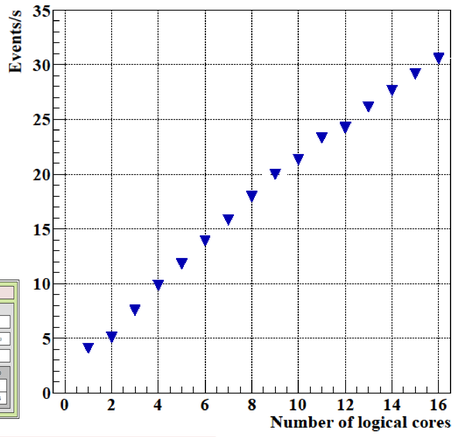


Computer cuda.jinr.ru:

- 2 CPUs Intel E5640
- 4 cores per CPU
- Hyper-Threading
- 2.7 GHz
- 12 MB L3 cache
- 48 GB RAM



Central events



Strong linear many-core scalability