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Visualisation of tracks using accurate model of ALICE detector magnets

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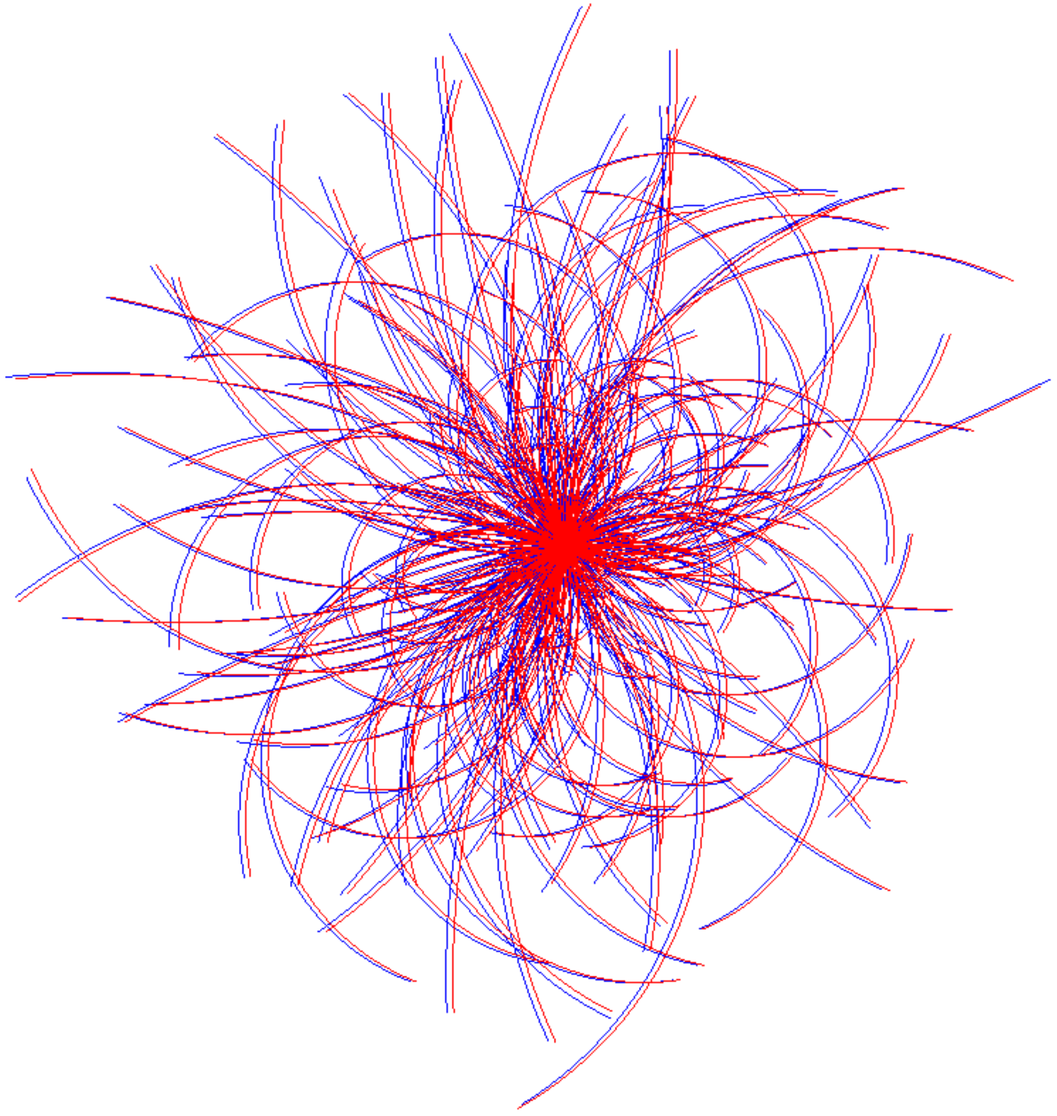
Introduction

- Reconstructed collision event data contains just the initial vertex and momentum of tracks
- ALICE Event Display uses `ROOT::TEveTrackPropagator` to re-propagate them
- Uniform constant magnetic field is assumed – only an approximation
- Detailed model of ALICE detector magnetic field from both magnets available, but not used for visualization so far
- Detailed model ported recently by our team to OpenGL for GPU rendering
- Now we ported the Propagator code to OpenGL and evaluated its performance
- We also tested how the detailed model influences tracking
- Full poster link:

http://mion.elka.pw.edu.pl/~pnowakow/QuarkMatter2022.pdf

Visual Inspection

- Tracks generated with constant field displayed here in red color
- Tracks generated with detailed field displayed here in blue color
- Slight differences in positions, curvatures and overall shape can be seen with a naked eye

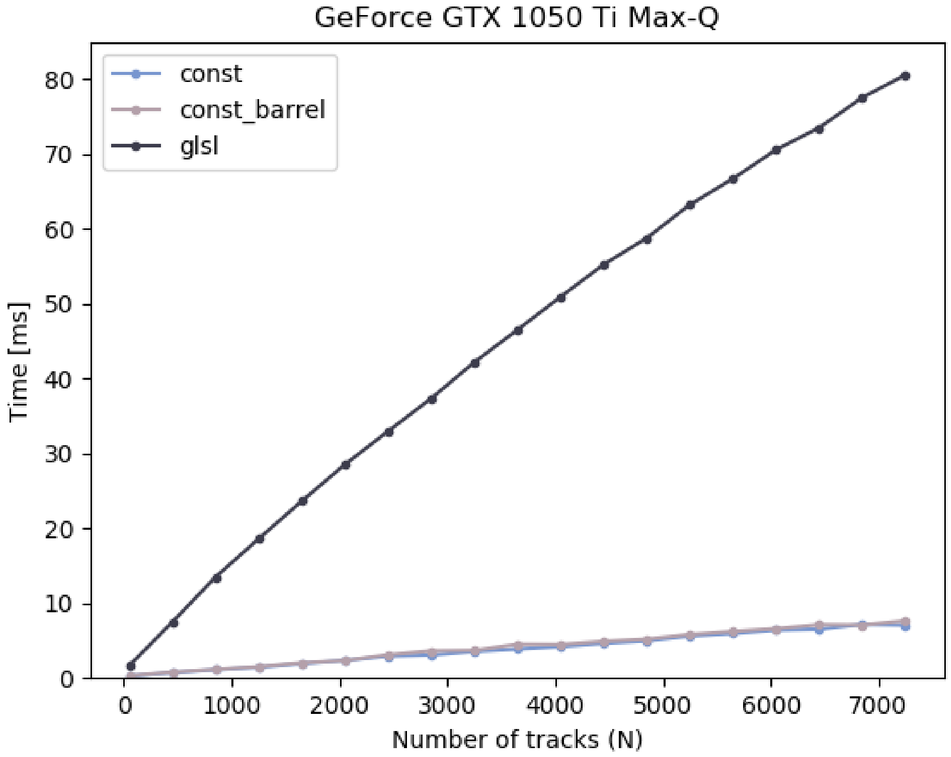


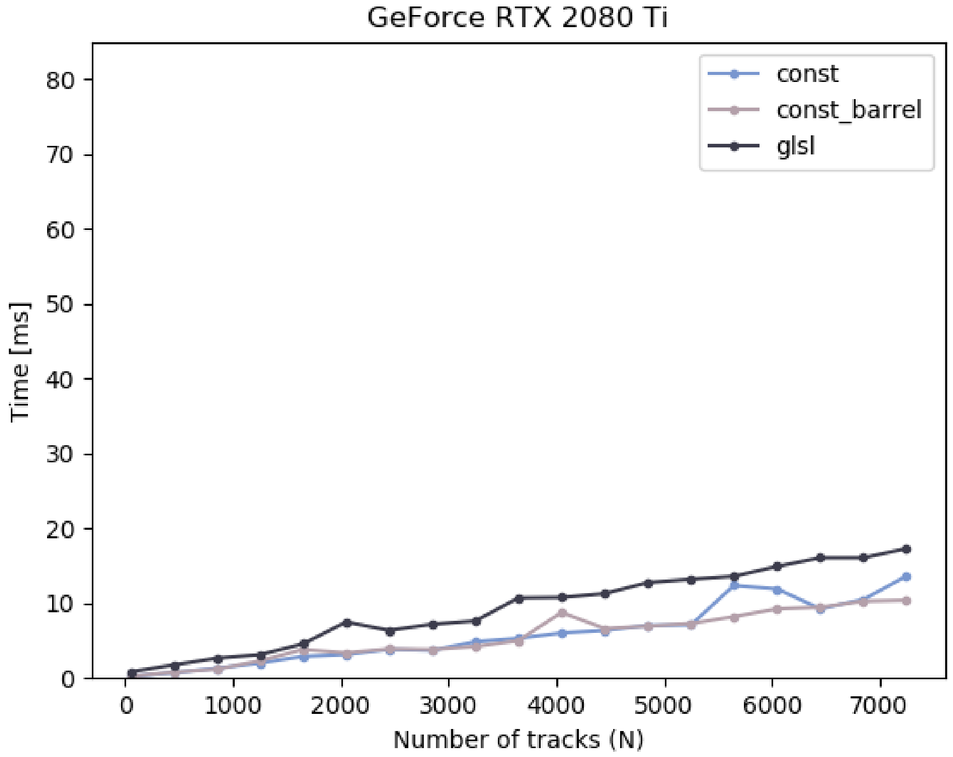
Measurement of track deviation

GPU	Algorithm	$\sqrt{\Delta x^2}$ [cm]	$\sqrt{\Delta y^2}$ [cm]	$\sqrt{\Delta z^2}$ [cm]
1050 Ti	Const	< 0.01	< 0.01	< 0.01
	Const Barrel	< 0.01	< 0.01	< 0.01
	GLSL	3.956	4.136	6.569
2080 Ti	Const	< 0.01	< 0.01	< 0.01
	Const Barrel	< 0.01	< 0.01	< 0.01
	GLSL	3.956	4.136	6.569

- Our propagator with: constant field (*Const*), constant field limited to ALICE barrel volume (*Const Barrel*), the detailed model (*GLSL*) versus `TEveTrackPropagator`
- No difference (down to floating point error) if constant field used - our implementation works correctly
- With the detailed model each track is displaced on average ~5 cm (vs const field)

Render Times





- Propagator with constant field runs with 60 FPS in every tested case on both GPUs
- Propagator with detailed field runs with 60 FPS on the RTX 2080 in every case; on the older card performance drops to ~20 FPS when ~4000 particles are rendered

Summary

- Particle propagation successfully executed on the GPU using OpenGL and its geometry shader stage
- Generated tracks equal (down to rounding errors) to `ROOT::TEveTrackPropagator` when used with constant magnetic field
- With accurate magnetic field model visible difference in shape of tracks
- GPU propagator using constant field model achieves very good performance even on older GPUs
- The older, mobile GPU struggles with the accurate model, achieving barely real-time performance (20 FPS) when tested with average particle count of a Pb-Pb collision (ca. 4000 particles)
- This is a non-issue on the more powerful card, which ran the propagation with 60 FPS or more in every tested case