The CUDA Center of Excellence in Dresden

An introduction

Guido Juckeland (guido.juckeland@tu-dresden.de)
Agenda

- Members
- Research Samples
- Planned Activity
15 Partners, 3 Institutions, 1 Roof

Electrical Engineering

Applied Mathematics

Radiation Physics

Structural Physics

Computer Graphics and Visualization

Database Technology

Embedded Systems

DRESDEN concept
Central infrastructure

Performance analysis and tuning

Help with porting of applications
Particle physics

Ion beam cancer therapy

Live radiation dose monitoring
Prof. Gumhold – TU Dresden, Computer Science

Computer graphics

Visualization

Interactive large scale simulations
Medical Physics/Biomedical Technique

Optical Coherence Tomography (OCT)

Doppler OCT
Databases

Speculative query processing

Special index structures
Ion-solid interaction

MD simulations

Semiconductor defects simulation
Structural physics

X-ray microscopy

X-ray tomography
Mathematical Libraries

MTL4

GMTL4
Prof. Tetzlaff, TU Dresden, Electrical Engineering

- Fundamentals of EE
- Epileptic seizure prediction
- EEG signal analysis

Guido Juckeland – Slide 16
Prof. Zerial, MPI-CBG

- Cell internal processes
- Quantitative microscopy
- Endocytosis research

Raw Image

PALM/STORM Image

x 20,000 frames

ZIH
Center for Information Services &
High Performance Computing

Guido Juckeland – Slide 17
Research Samples
3D3V relativistic particle-in-cell code
Villasenor-Buneman charge conserving current deposition
NGP / CIC / TSC macro-particle distribution functions
Boris Push particle pusher
Yee-scheme / Directional splitting Maxwell-Solver
PIConGPU Scaling

Scaling PIConGPU 3D on TESLA M2090
weak scaling: 28 mill. particles, 192x192x192 cells per GPU
strong scaling: 535 mill. particles 512x512x512 cells

relative runtime

GPUs

Guido Juckeland – Slide 20
Zeit für Video ???
Ptychography – Instant Image Analysis

- Resolution not limited by properties of the optics
- Coherence properties of the beam preserved
- Focusing yields a gain of $10^4$ in photon density
- $1.5 \cdot 10^6$ photons/nm$^2$

→ Record resolution of 5 nm
Ptychography - Speedup

Speedup by a factor of 233:
a factor of 24 is related to the GPU-implementation and factor of 10 to an optimized CPU-code.

calculation time: 1h -> 15s!

Wolfgang Hoenig: Großer Beleg
Event Logging for Performance Analysis

Host

GPU

foo event launch event foo Sync_wait

cpu execution queue

bar

47110815 Event
47111234 Event
Planned Activity
Joint activity

Teaching
- Joint CUDA/OpenCL class
- Integration into individual courses

CUDA Coffee every 2 weeks
- Discuss current research

CCoE Seminar every month
- Invited speakers present their GPU related work

CCoE Workshop once a year
- Presentation platform for broader audience
Thank you!