HASEonGPU talk - AAC jena 2014

E. Zenker, C. Eckert

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1 Outline

1. ASE physics (not too much details!)
   (a) gain medium is pumped
   (b) spontaneous emission of photons
   (c) amplification of photons
   (d) loss of pumped energie (pump plot + 3D dndt ASE)
   (e) motivation for ASE flux calculation in laser physics
      - wall plug efficiency, for efficient laser systems (use cases)
      - higher resolution of gain medium
      - large gain media
      - fundamental process (no simplified formula)
      - there are no tools able to simulate ASE fast
      - ASE sim $\rightarrow$ Temp $\rightarrow$ optical, mechanical transformation $\rightarrow$ ASE sim (multiscale simulation)
2. simulating ASE with Monte Carlo (transition to parallel simulation)
   (a) describe meshed gain medium
   (b) Φ ASE formula
   (c) describe Monte Carlo integration in general (see wikipedia)
   (d) transformation of Φ ASE formula to Monte Carlo integration formula

(e) Monte Carlo integration solved by raytracing

3. parallelization of Monte Carlo (main focus!)
   (a) Monte Carlo is suitable for usage of accelerator hardware (CUDA)
   (b) rays
      i. processing of rays by threads
      ii. distribution of rays (IS, load balancing on ray level)
      iii. memory usage
      iv. MSE
      v. AS + RS
   (c) sample points
      i. load balancing on sample point level (MPI)
4. result
   (a) validation
      - experiment plot + simulated mesh and size of simulation
      - simulation plot (no fit!)
      - give feeling for runtime of whole simulation
   (b) runtime (CPU vs. GPU also for whole simulation aproximated)
   (c) scaling
      - large gain media, require large cluster systems
      - almost perfect strong scaling of Monte Carlo code
   (d) conclusion
      - future: ASE simulation of massive gain media
      - simulate loop for large gain media in reasonable amount of time