GPU Performance, TD solver

Speedup of solver loop time as compared to dual Xeon E5-2643 v3 CPUs

- MRI Application (110 million cells)
- PCB Board (16.4 million cells)
- Head and Phone (137 million cells)

Solver Loop Speedup

- 1x Tesla K80
- 2x Tesla K80

CPU and GPU resources are used in parallel to optimize performance.
GPU Computing — Typical Performance

The features which need the largest amount of memory on the GPU are:

- Dispersive materials
- Lossy metal
- Open boundaries

Not sure whether your models will benefit from GPU Computing? Send us a test model and we will run a benchmark with your model on different GPU hardware!
Since CST STUDIO SUITE 2016 the Asymptotic Solver can be accelerated using up to eight GPU boards in a single host system. Using distributed computing the performance of the solver can be pushed even further.
GPU Performance, I solver

Speedup of matrix factorization time (GPU accelerated) and total simulation time as compared to dual Xeon E5-2643 v3 CPUs
The Particle-In-Cell (PIC) Solver of CST PARTICLE STUDIO can be accelerated by a single GPU.

Especially, the computations required to compute the electromagnetic fields excited by the particle movement benefit from GPU acceleration.

Speedup of total simulation time as compared to dual Xeon E5-2643 v3 CPUs
Typical GPU System Configurations

**Entry level**
- Workstation with 1 GPU card
  - Available "off the shelf"
  - Good acceleration for smaller models
  - Limited model size (depends on available GPU memory and features used)

**Professional level**
- Workstation/server with multiple internal or external GPU cards
  - Many configurations available
  - Good acceleration for medium size and large models
  - Limited model size (depends on available GPU memory and features used)

**Enterprise level**
- Cluster system with high-speed interconnect.
  - High flexibility: Can handle extremely large models using MPI Computing and also a lot of parallel simulation tasks using Distributed Computing (DC)
  - Administrative overhead
  - Higher price

CST engineers are available to discuss with you which configuration makes sense for your applications and usage scenario.
All cards of the 3100, 5100, 7100 series are supported by the transient solver of CST STUDIO SUITE® 2015 and later.

Transient solver benefits from high memory bandwidth of the Xeon Phi™ accelerator card.

![Graph showing speedup of solver loop](image-url)

Speedup of Solver Loop

- Antenna Coupling: 60 million cells
- Lightning Strike: 90 million cells

Solver performance on Xeon Phi 7120X relative to dual Xeon E5-2697 v2.
Hardware Consulting and Benchmarking

Our close collaboration with hardware manufacturers and system integrators allows us to help you select the best-in-class solution for your investment.

Hardware consulting service range from **review of system configurations** regarding optimal performance for a certain solver (low end) to **intense benchmarking and analysis** (high end).

- Laptop
- Workstation
- Rack-Server
- Clusters / Shared Memory Systems
CST STUDIO SUITE® offers native support for high speed/low latency networks

**MPI Cluster System**
CST STUDIO SUITE Frontend

Cluster Interconnect
GPU Hardware

**Note:** A GPU accelerated cluster system requires high-speed network in order to perform well!

**Speedup of Total Simulation Time**

<table>
<thead>
<tr>
<th>Number of Cluster Nodes</th>
<th>Speedup</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

Hardware: dual Xeon E5-2643 v3 processors, 256GB RAM per node (1833MHz), Infiniband FDR interconnect (56Gb/s), two GPU cards (Tesla K80) per cluster node.