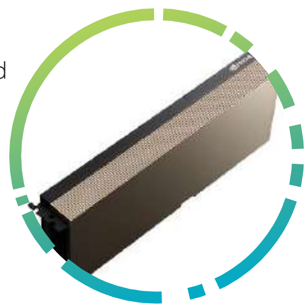
High-performance computing for acoustic simulation with GPU acceleration

Accelerate your acoustic simulations with state-of-the-art GPU computing

Throughout the years, simulation models have grown in size as companies strive for higher fidelity when simulating the physical behavior of products. For acoustic simulation, where the model size is related to the size of the studied object and the required frequency, larger models can provide greater insight as they can capture more accurately the response in the system and component level as well as in higher frequencies.

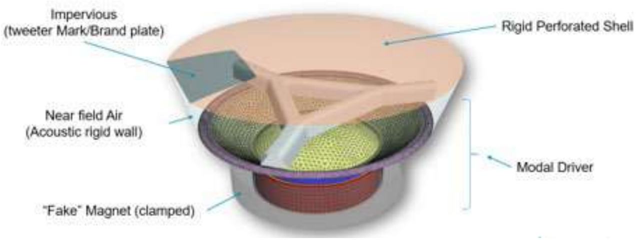
The ability to solve larger models has been driven by the evolution of computing power as well as numerical methods. In terms of computing power, the evolution of traditional CPU technology has driven the improvements in computational gains. Lately, GPUs have emerged as the next big enabler of computational gains in large physical system simulation especially when complex computing tasks can be subdivided and distributed across their very large number of computing units.

Since 2016, Actran's high-order, time-domain finite element solver based on the Discontinuous Galerkin Method (DGM) has been taking advantage of the GPU technology to significantly accelerate high-frequency acoustic simulations. Thanks to the high order representation of the solution inside elements and the solution discontinuity between elements, Actran DGM is a perfect candidate for GPU acceleration. A deep code restructuring has been done and the CUDA framework has been integrated. This results in an accelerated version of Actran DGM for NVIDIA GPUs, making Actran the only code utilizing GPU acceleration for acoustic simulation. Since then, GPU acceleration has also been integrated into the classic, frequency-based finite element solver, MUMPS.



NVIDIA A100 Tensor Core GPU

Tweeter model



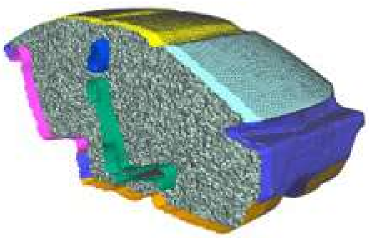
3x
speedup
with 4 GPUs

In comparison with 240 CPU processes

96%
reduction in RAM memory
with 1 GPU

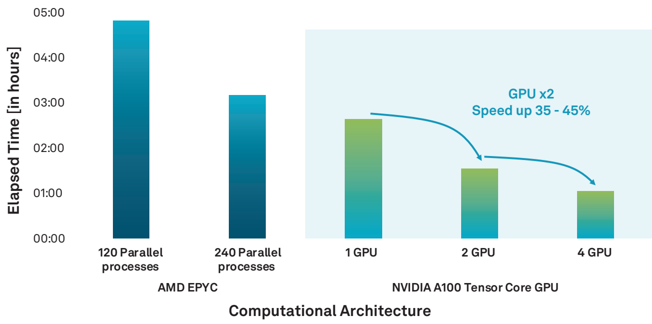
In comparison with 240 CPU processes

Cavity model



When using a single NVIDIA® A100 Tensor Core GPU, compared to using 240 **AMD EPYC 7V12 @ 2.40 GHz** CPU processes, a reduction both in computation time and memory is achieved by 10% and 96% respectively. By using two NVIDIA A100 GPUs, the calculation is consistently sped up by 40% and with 4 GPUs, the computation is solved 3 times faster than with 240 CPU processes.

DGM cavity information	
Cavity volume	2.84 m³
Number of dofs	540,694,708
Number of 3D elements	1,493,037
Average of element order	6.1



Alternative to numerical strategies

The use of a GPU for DGM calculations has two benefits: the primary one is the reduction of the time for solution; a secondary one is that the memory required for the calculation is significantly reduced. To showcase these effects, a 540 million degree-of-freedom (dof) loudspeaker installation case up to 20,000 Hz where Actran DGM computes the loudspeaker response in a vehicle passenger cabin. Loudspeaker performance is important up to the limit of the auditory spectrum at 20,000 Hz and the installation in a vehicle cabin presents a computational challenge for the classic finite element approach due to its large size and high frequency required. Actran DGM can easily handle such simulations thanks to efficient parallelization and GPU acceleration.

Furthermore, larger models than the current one, such as a pass-by noise simulation of a truck, can be solved as the memory requirements when using GPU acceleration are significantly reduced.

Learn more about high-performance computing with Actran, visit fft.be/services/hpc. If you want to get more personalized information about how Actran can be sped up or made to fit to your hardware, contact us at support@fft.be or your local account manager.

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