Simulation on HP cluster

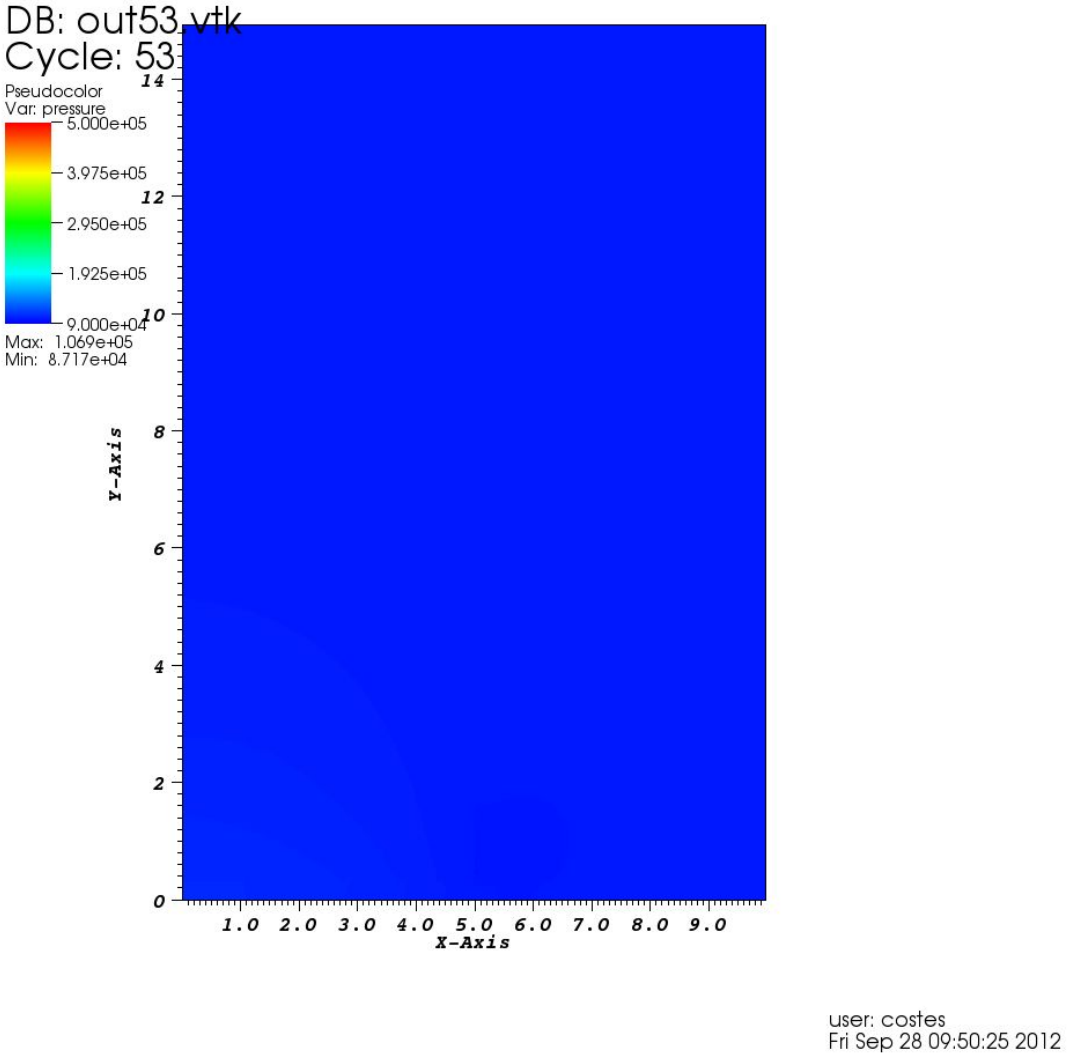


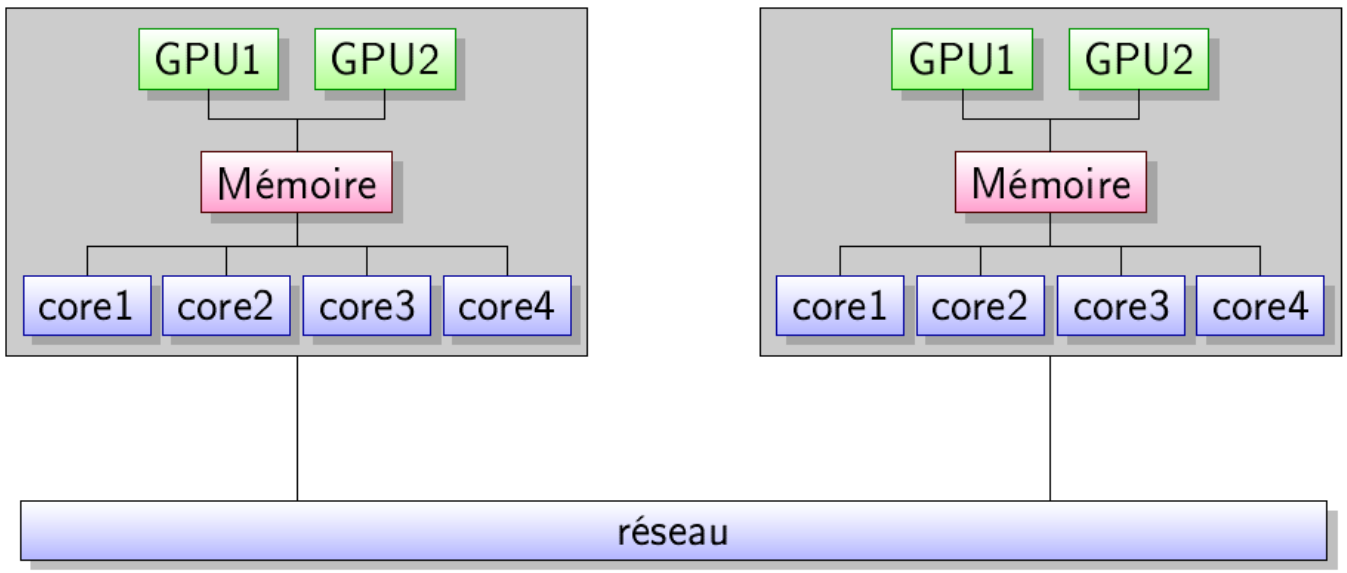
FIGURE: Pressure. Free fall of a liquid block in a gas with 4M cells, HP cluster (Full MPI with 200 cores).

Summary of the MPI+OpenMP parallelization

- The numerical results show the efficient contribution of OpenMP when the number of cores increases (from ≈ 200 cores) ;
- The use of OpenMP allows to decrease the number of MPI communications ;
- We expect the hybrid code will be all the more successful (compared to the Full-MPI code) as the calculations will be massively parallel and executed on modern architectures (many-cores).

GPU migrating with HMPP

GPU migrating



- A migration to GPU's with HMPP (Collaboration with CAPS entreprise) has been done only for the "mono-material part" of the code (70% of the total computational time).
- x7 for one material and x2 for multi-materials.
- This version is coupled with the MPI parallelization.

Summary of the GPU migrating

- As well as OpenMP, HMPP allows an incremental programming : We can add gradually pragma directives while keeping a CPU functioning ;
- We have replaced OpenMP directives by HMPP directives : The restructuring work is essentially the same ;
- No need to know Cuda or OpenCL ;
- We keep only one version of the code ;
- The coupling with the MPI version is easy since we have no communication in the “HMPP regions” ;
- HMPP allows to generate Cuda or OpenCL code, which allows to migrate the code on various graphics cards (NVIDIA, ATI) ;
- Currently, 30% of the code remains sequential. The global efficiency is then limited ;
- If a GPU becomes unavailable during an execution, the run can switch to CPU ;
- During a GPU treatment, an other part of the code can be executed on CPU (Non-blocking transfers to the GPU).

Concluding remarks and further works

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- We have introduced a MPI parallelization of the NIP method using a domain decomposition in slices and transpositions.
- All MPI communications are localized in the transposition between two steps of the directional splitting.
- An OpenMP parallelization and a GPU migration have been done. The hybrid code MPI+OpenMP and MPI+GPU allows to take advantage of hybrid multi-core architectures.
- In an effort to make it easier for programmers to take advantage of parallel computing, NVIDIA, Cray Inc., the Portland Group (PGI), and CAPS enterprise have announced a new parallel-programming standard, known as OpenACC.
- Massively parallel simulations will be executed on the **Curie supercomputer**, owned by GENCI and operated into the TGCC by CEA.

Les Simulations 4 000 Coeurs et GPU ont été passées sur ....