E4 COMPUTER ENGINEERING

WHEN PERFORMANCE MATTERS

THE OPEN-CLOSED COOLING DRIVAER VARIANT WITH STATIC MESH CHALLENGE ON ADVANCED COMPUTING PLATFORMS

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E4 COMPUTER ENGINEERING

E4 Computer Engineering designs and manufactures highly technological solutions for **HPC** Clusters, **Cloud**, **Data Analytics**, **Artificial Intelligence**, **Hyper-Converged infrastructure** and **Quantum Computing** for the Academic and Industrial markets. We have been collaborating for years with the main research centers at national and international level (CINECA, CERN, ECMWF, LEONARDO) and we are involved in national and **European projects** in the HPC, Quantum Computing, and AI fields.

Each E4 solution is **UNIQUE**, like every one of our customers; **TESTED** in every single component; **VALIDATED** to verify the actual performance of each system and **SERVICED** by technicians who provide assistance in the most extensive and complex Italian and European computing infrastructures.

E4 ANALYTICS

LET YOUR DATA PAY YOUR GROWTH

Through the sister company E4 Analytics, E4 works to integrate **Artificial Intelligence** and **Data Science** in organizations that undertake the **Digital Transformation** of their business to improve products/processes and optimize resources. We operate at the intersection between business and technology, supporting the customer in the adoption of customized and secure **GenAI solutions**: with E4 Analytics, company data become a **resource for creating value**, enhancing **innovation** and **competitiveness** in the marketplace.

TESTING ADVANCED COMPUTING PLATFORMS: THE FRONTIER BEYOND CURRENT HPC SOTA

AMD Genoa @E4
2x AMD EPYC 9554 (Genoa)
x86_64
64 cores/processor (128 cores/node)
256 MB L3 cache/socket
500k MB DDR5-4800 RAM

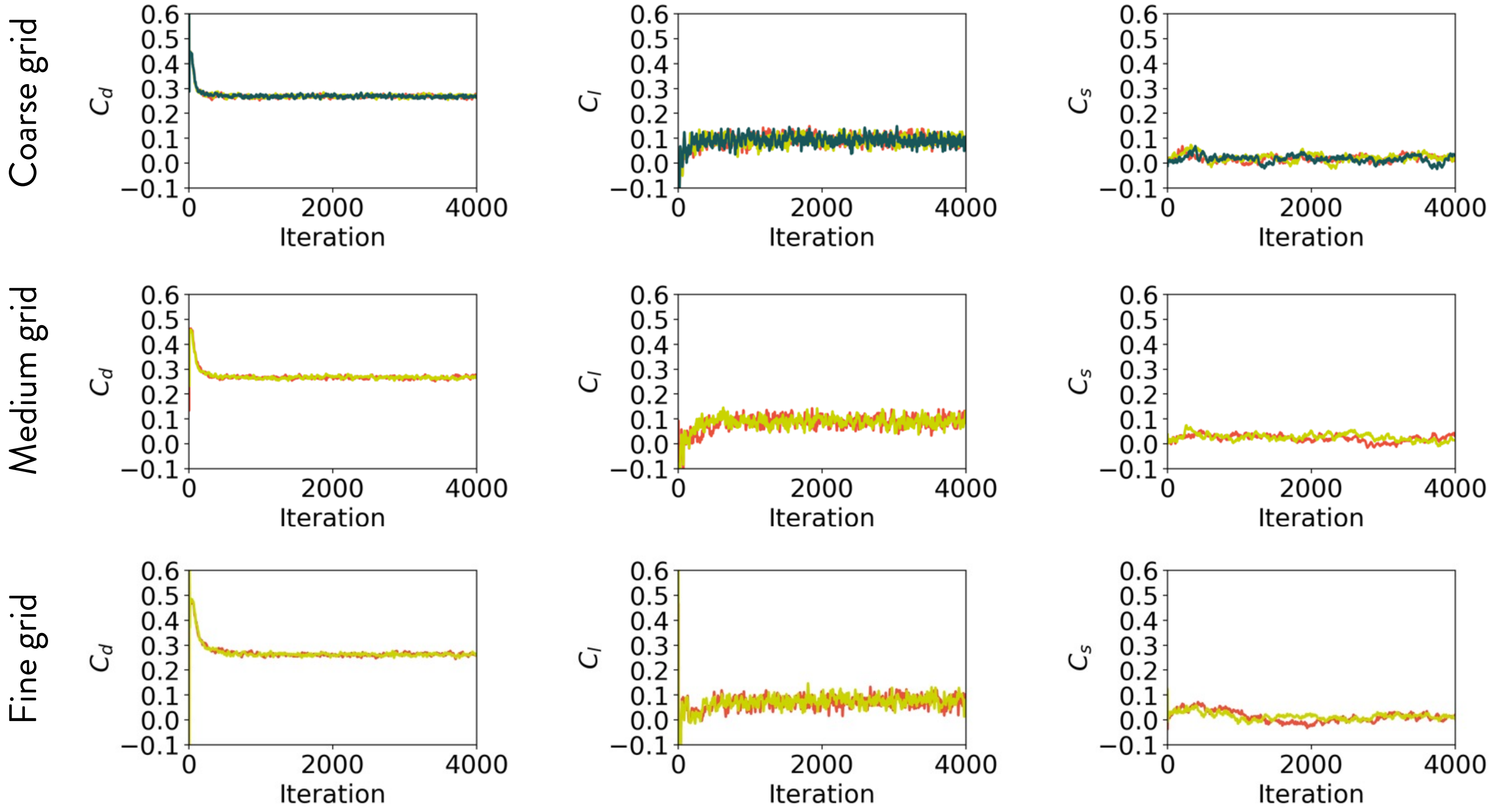
360 W/processor
Software stack
GNU 12.4.0
Open MPI 4.1.4

NVIDIA Grace SuperChip @E4
2x Nvidia Grace
Arm Neoverse V2
72 cores/processor (144 cores/node)
114 MB L3 cache/socket
450k MB LPDDR5 RAM

500 W/node
Software stack
GNU 13.3.0
Open MPI 5.0.3
Extra compiler flags
-mcpu=native

INTEL Sapphire Rapids @IT4I
2x Intel® Xeon® CPU Max 9468
x86_64
48 cores/processor (96 cores/node)
105 MB L3 cache/socket
256 GB DDR5-4800 RAM
128 GB HBM
350 W/processor
Software stack
GNU 11.3.0
Open MPI 4.1.4
Extra compiler flags
-march=sapphirerapids
-mtune=sapphirerapids

PHYSICS RESULTS CONSISTENT ACROSS ALL ARCHITECTURES AND GRID CONFIGURATIONS



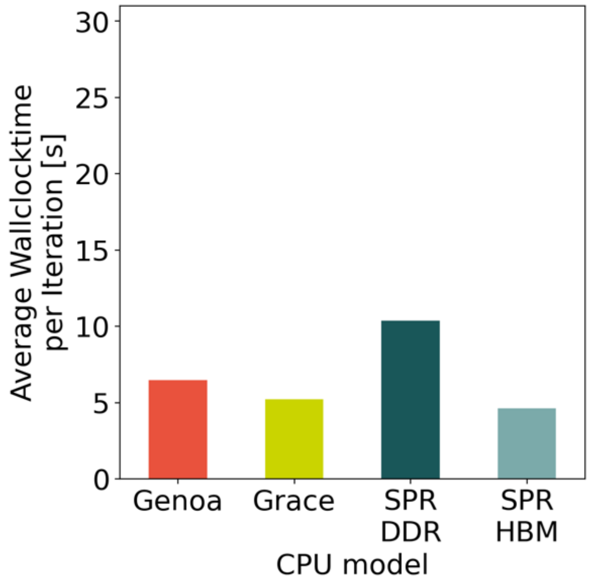
AMD Genoa, NVIDIA Grace, INTEL SPR HBM, INTEL SPR DDR

HBM ACCELERATES COMPUTATION BUT FACES MEMORY BOTTLENECKS ON MEDIUM/FINE GRIDS

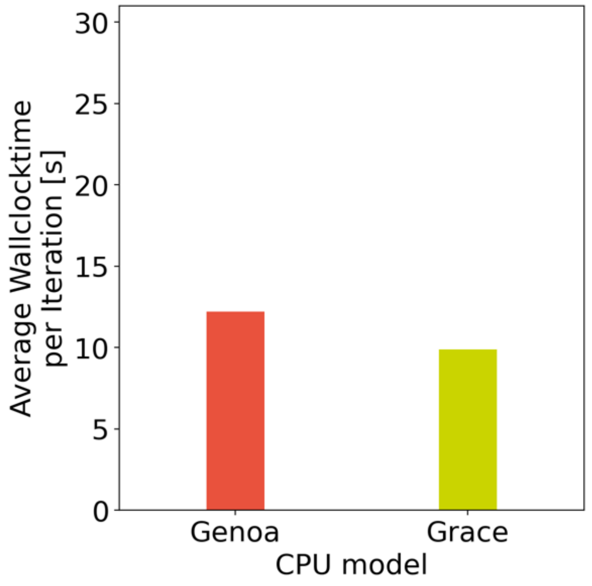
Full node comparison

AMD Genoa: 128 cores, NVIDIA Grace: 144 cores, INTEL SPR DDR: 96 cores, INTEL SPR HBM: 96 cores

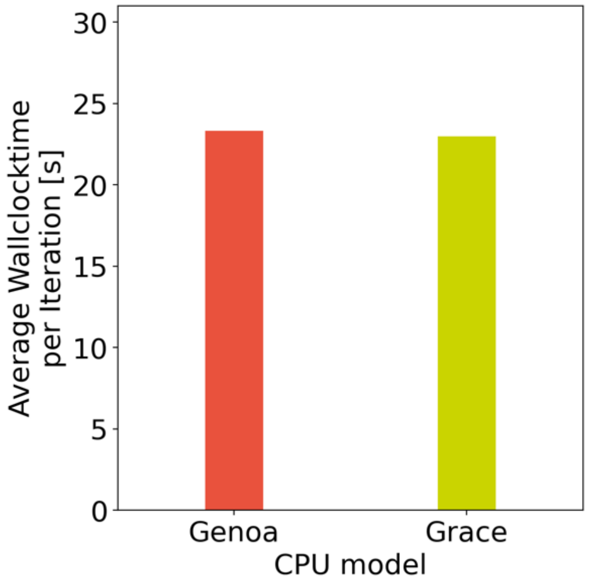
Coarse grid



Medium grid



Fine grid

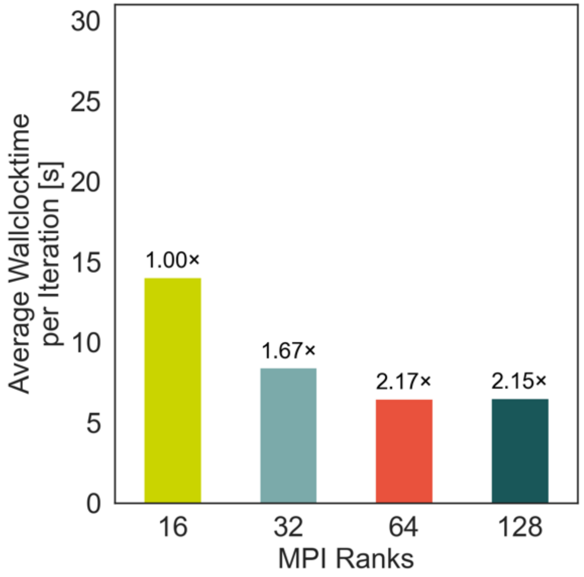


On INTEL SPR, binding to DDR `numactl --membind 0-7`, binding to HBM `numactl --membind 8-15`

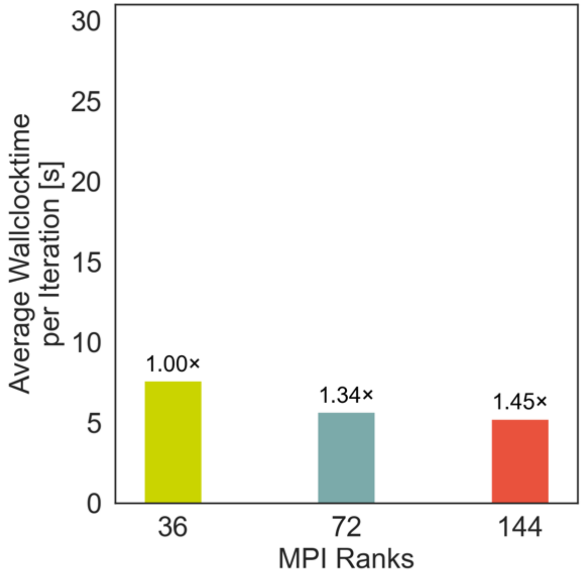
FULL-NODE UTILISATION SHOWS LITTLE GAIN ON THE COARSE GRID

Coarse grid

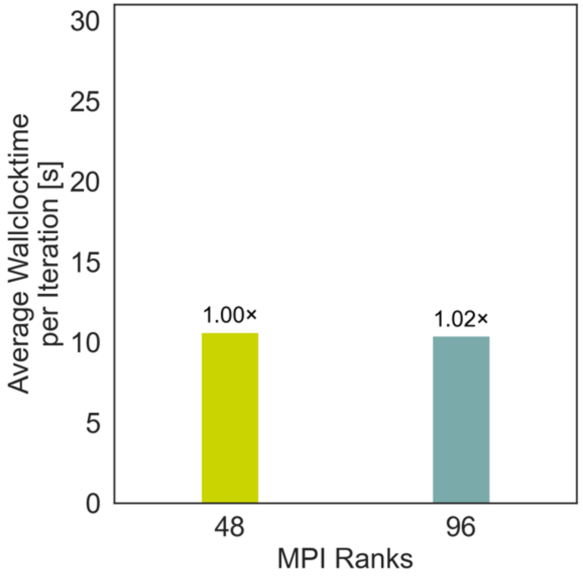
AMD Genoa



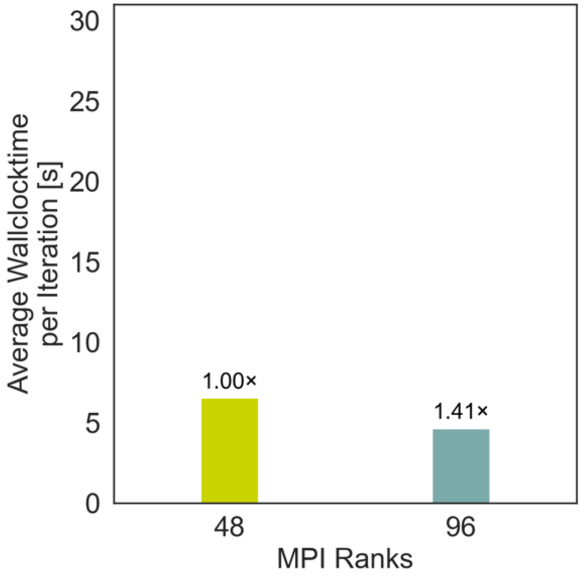
NVIDIA Grace



INTEL SPR DDR



INTEL SPR HBM



Node requested exclusively
Simulation launched with

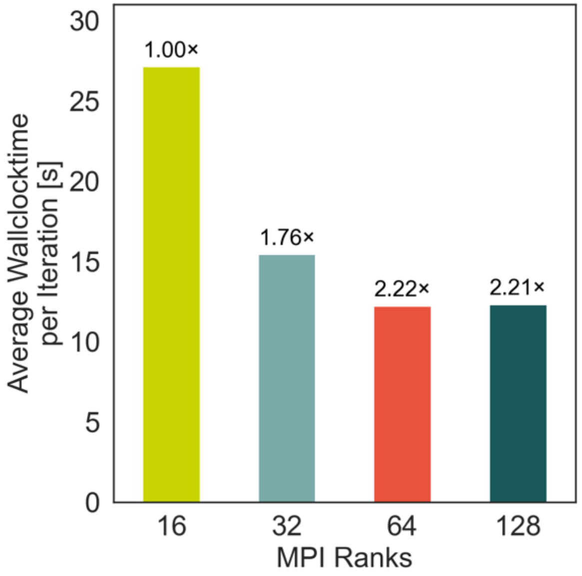
```
mpirun -np ${nProcs} --bind-to core --map-by ppr:${nProcs}:node:PE=${dist}
```

where `nProcs` is the number of MPI tasks and `dist` the number of processing elements assigned per process (total cores/nProcs)

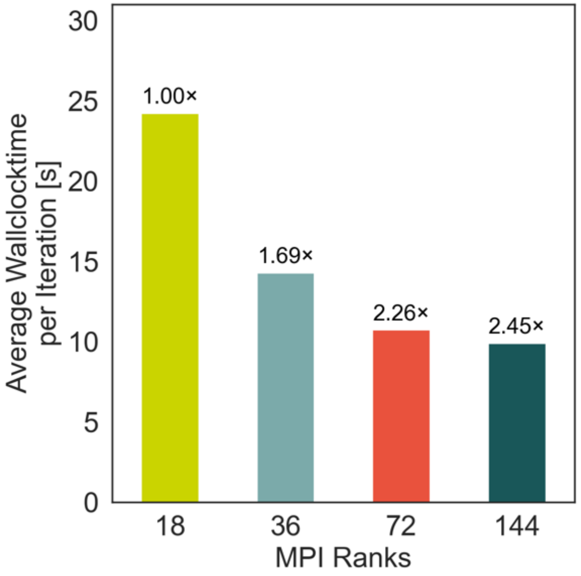
SCALABILITY WITH THE MEDIUM GRID REMAINS POOR ON BOTH AMD GENOA AND NVIDIA GRACE

Medium grid

AMD Genoa



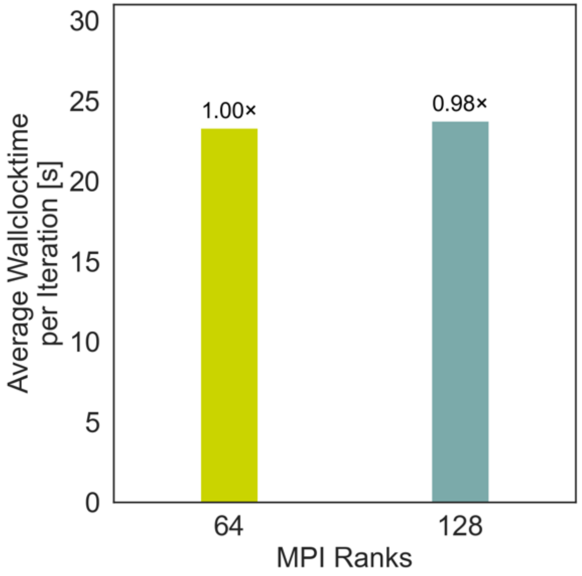
NVIDIA Grace



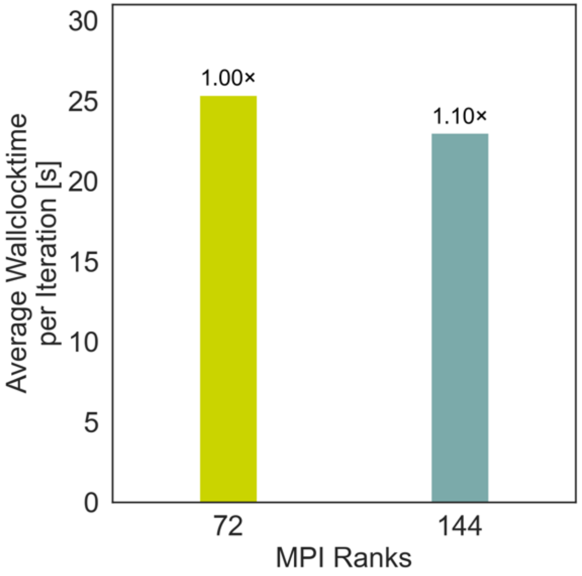
USING HALF A NODE ON GENOA YIELDS BETTER PERFORMANCE ALSO WITH FINE GRID

Fine grid

AMD Genoa

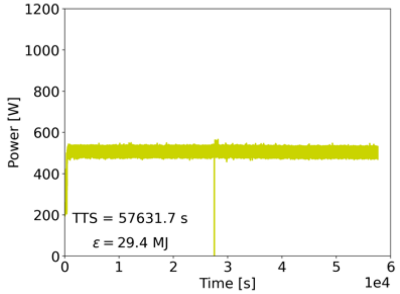


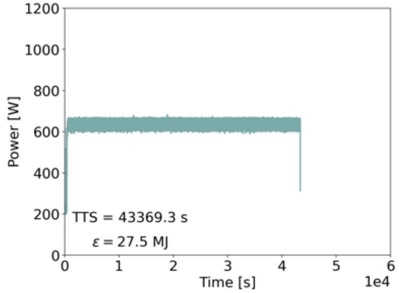
NVIDIA Grace

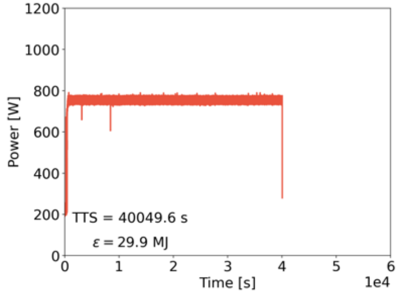


UNDER THESE NODE CONFIGURATIONS FASTER TTS TRANSLATES TO LOWER ENERGY CONSUMPTION

Power absorption time series on Grace







Coarse grid

Architecture	Cores	TTS [s]	Energy [MJ]
AMD Genoa	64	26435.4	19
NVIDIA Grace	144	21187.7	15.3
INTEL SPR	96	20957.1	13.7

Medium grid

Architecture	Cores	TTS [s]	Energy [MJ]
AMD Genoa	64	49793.7	35.9
NVIDIA Grace	144	39951.6	28.8

Fine grid

Architecture	Cores	TTS [s]	Energy [MJ]
AMD Genoa	64	94138.1	67.8
NVIDIA Grace	144	92777.8	66.8

SUMMARY

- We evaluated the Open-closed cooling DrivAer variant using a static mesh OpenFOAM simulation across a range of advanced computing platforms featuring both x86_64 and ARM CPUs.

- The physics results were consistent across all tested architectures and grid configurations.

- OpenFOAM performance benefits from the use of High-Bandwidth Memory (HBM), though parallel scalability remains suboptimal on all platforms and grid resolutions analysed.

- Among the available node configurations, shorter time-to-solution correlates with lower energy consumption.