

Showcase

ExaSMR: NekRS Performance on Ponte Vecchio

Ponte Vecchio with Intel OneAPI DPC++ implementation

1.5x performance lead

ExaSMR: Small modular reactors (SMRs) and advanced reactor concepts (ARCs) will deliver clean, flexible, reliable, and affordable electricity while avoiding the traditional limitations of large nuclear reactor designs,

<https://www.exascaleproject.org/research-project/exasmr/>

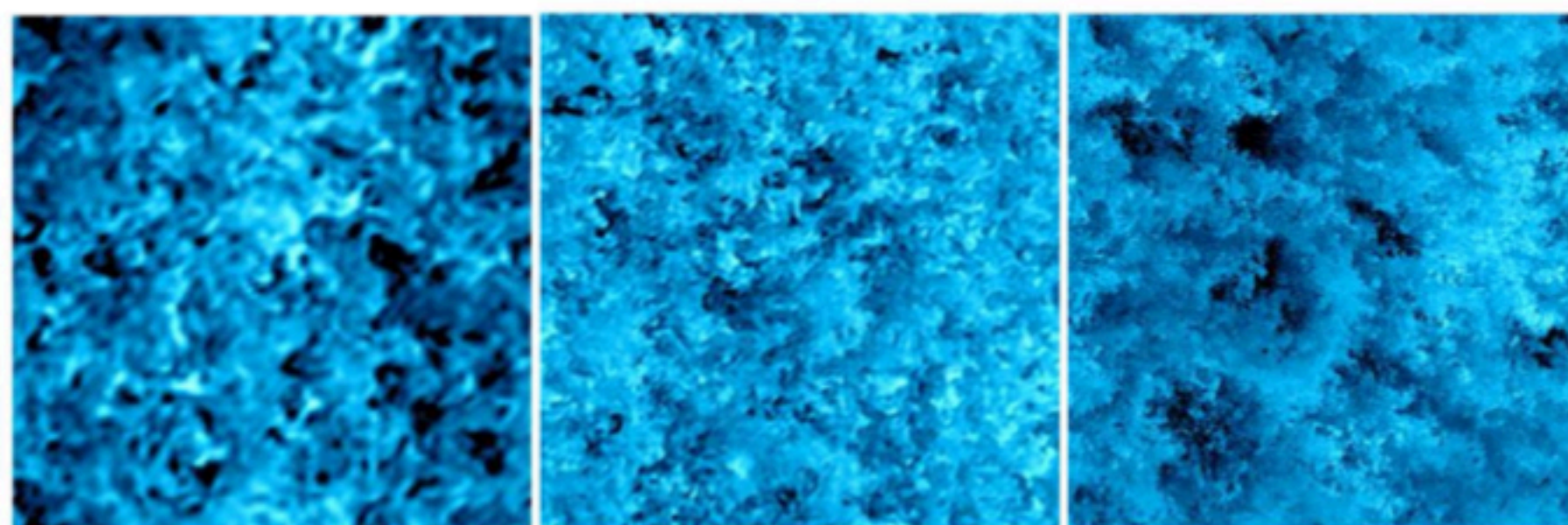
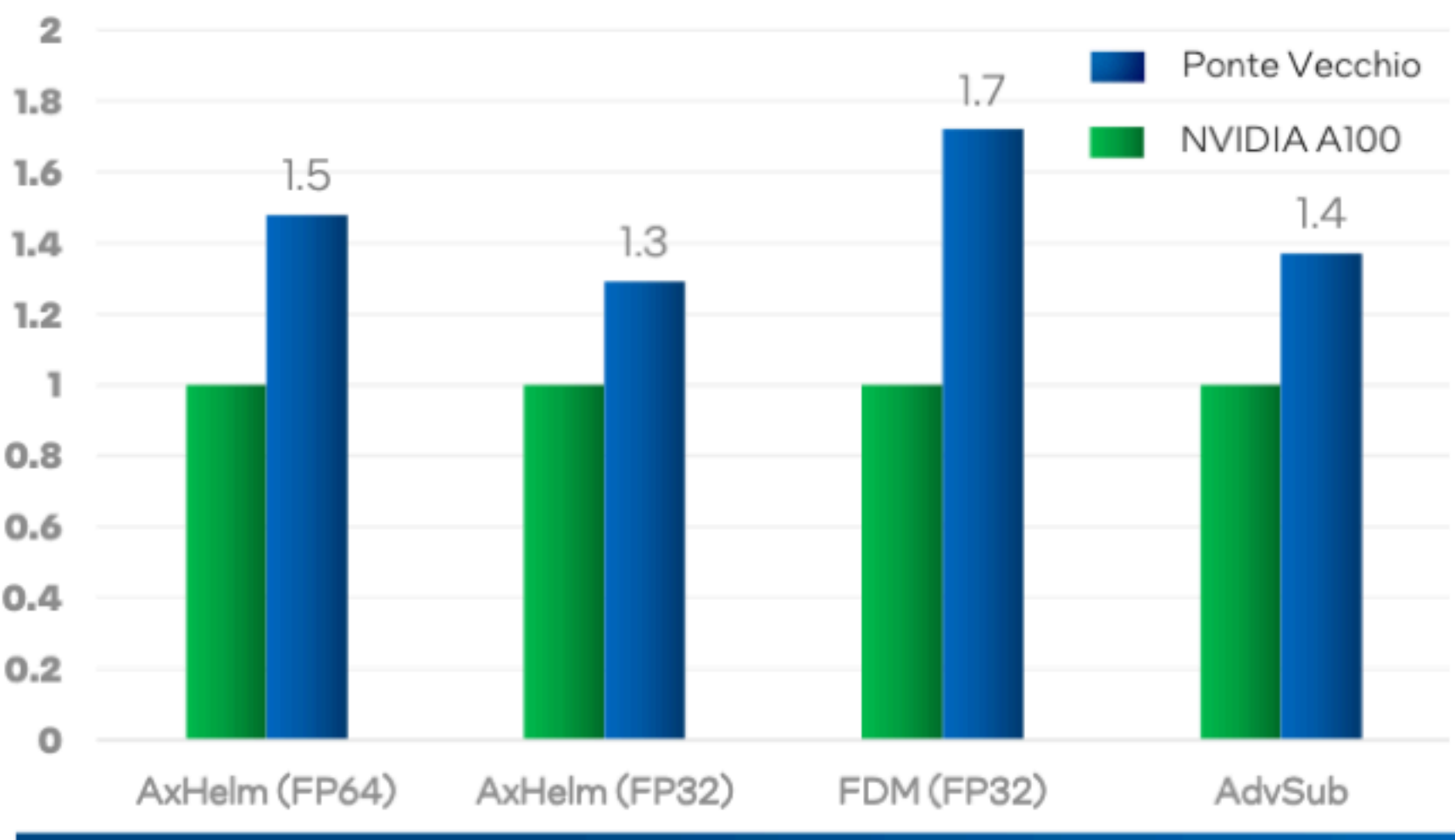


Figure 10: NekRS: potential temperature distributions in [K] at time 6h and $z=100\text{m}$ on different resolutions of $\Delta x=3.12\text{m}$ (left), 1.56m (center), and 0.78m (right) corresponding to the number of grid points, $n=128^3$, 256^3 , and 512^3 , respectively. Δx represents the average grid-spacing for the spectral elements, $E=16^3$, 32^3 and 64^3 and the polynomial order $N=8$ on the domain $400\text{m} \times 400\text{m} \times 400\text{m}$.

<https://ceed.exascaleproject.org/docs/ceed-ms38-report.pdf>

Relative Performance of NekRS Benchmarks w/ problem size of 8196 (Averaged throughput, higher is better)



Application Summary:

NekRS is an open-source Navier Stokes solver based on the spectral element method targeting classical processors and accelerators like GPUs. The code started as a fork of libParanumal in 2019. For API portable programming OCCA is used.

<https://github.com/argonne-lcf/nekRS/>

OCCA is an open-source library which aims to make it easy to program different types of devices (e.g. CPU, GPU, FPGA). It provides a unified API for interacting with backend device APIs (e.g. OpenMP, CUDA, OpenCL), uses just-in-time compilation to build backend kernel, and provide a kernel language, a minor extension to C, to abstract programming for each backend.

<https://libocca.org>



- See backup for workloads and configurations. Results may vary.
- Intel does not endorse or make any representation or warranty for the use of the Intel OneAPI DPC++ implementation in this application.

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H. Jiang, "Intel's Ponte Vecchio GPU : Architecture, Systems & Software," 2022 IEEE Hot Chips 34 Symposium (HCS), 2022, pp. 1-29, doi: 10.1109/HCS55958.2022.9895631.

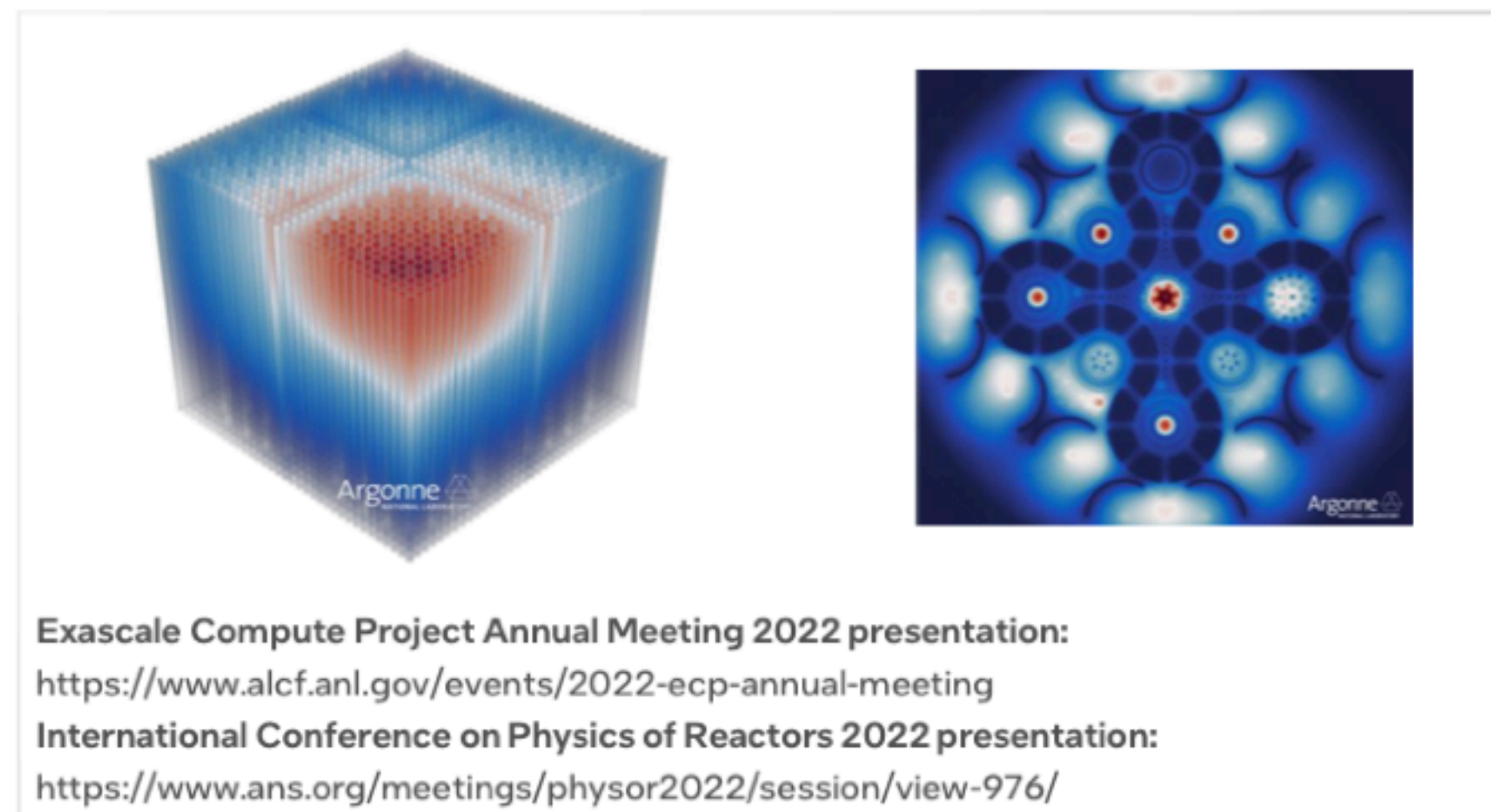
Showcase

ExaSMR: OpenMC Performance on Ponte Vecchio

Monte Carlo particle transport code for exascale computations

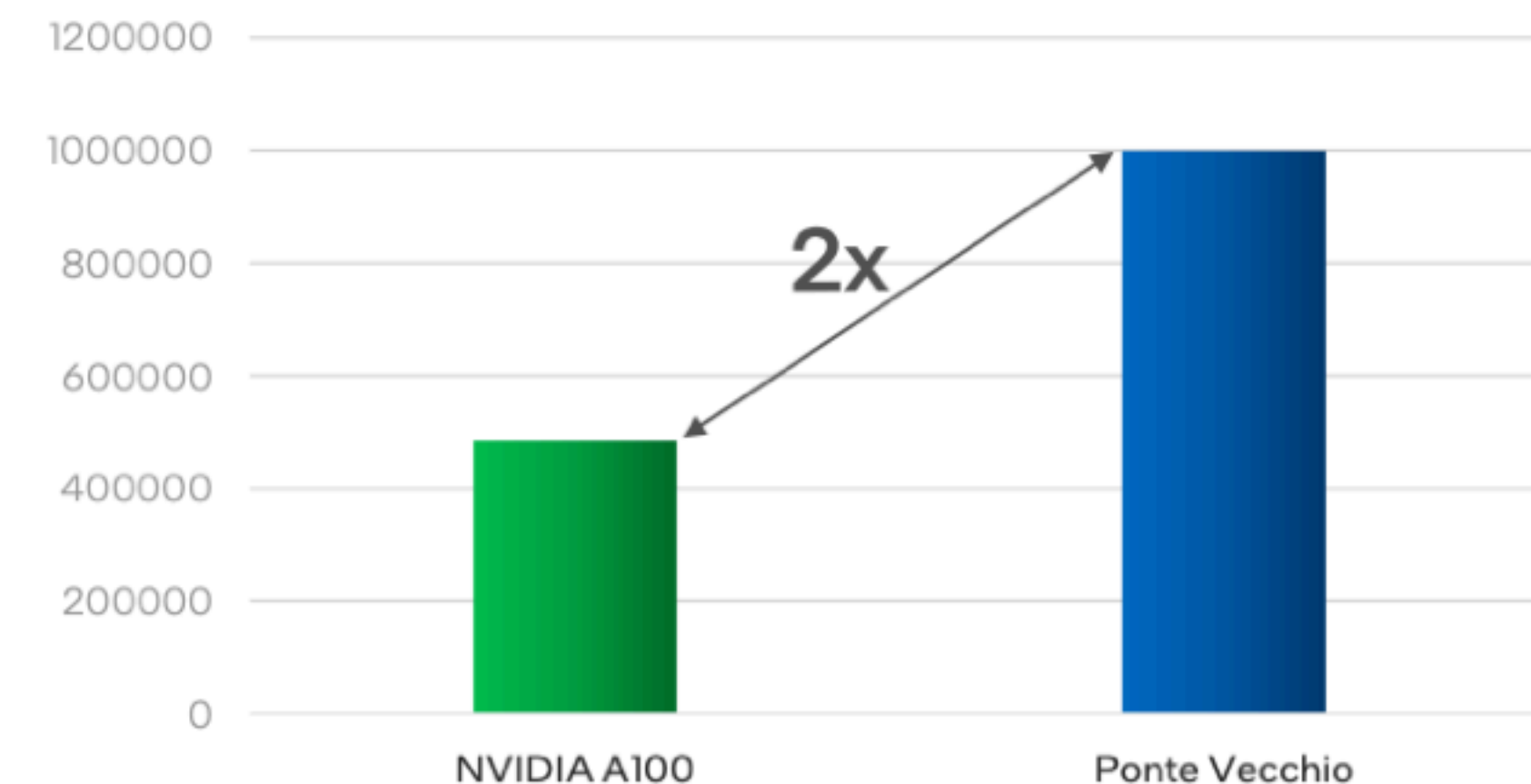
Ponte Vecchio with OpenMP Target offload

2x performance lead



<https://docs.openmc.org>

OpenMC Depleted Fuel Inactive Batch Performance
on HM-Large Reactor with 40M particles
(particles/second, Higher is better)



Application Summary: OpenMC is a Monte Carlo particle transport application that has recently been ported to the OpenMP target offloading programming model for use on GPU-based systems. The Monte Carlo method employed by OpenMC is considered the "gold standard" for high-fidelity simulation while also having the advantage of being a general-purpose method able to simulate nearly any geometry or material without the need for domain-specific assumptions. However, despite the extreme advantages in ease of use and accuracy, Monte Carlo methods like those in OpenMC often suffer from a very high computational cost. The extreme performance gains OpenMC has achieved on GPUs, as compared to traditional CPU architectures, is finally bringing within reach a much larger class of problems that historically were deemed too expensive to simulate using Monte Carlo methods. The leap in performance that GPUs are now offering carries with it the potential to disrupt a number of engineering technology stacks that have traditionally been dominated by non-general deterministic methods. For instance, faster MC applications may greatly expand the design space and simplify the regulation process for new nuclear reactor designs -- potentially improving the economics of nuclear energy and therefore helping to solve the world's climate crisis.



- See backup for workloads and configurations. Results may vary.
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H. Jiang, "Intel's Ponte Vecchio GPU : Architecture, Systems & Software," 2022 IEEE Hot Chips 34 Symposium (HCS), 2022, pp. 1-29, doi: 10.1109/HCS55958.2022.9895631.