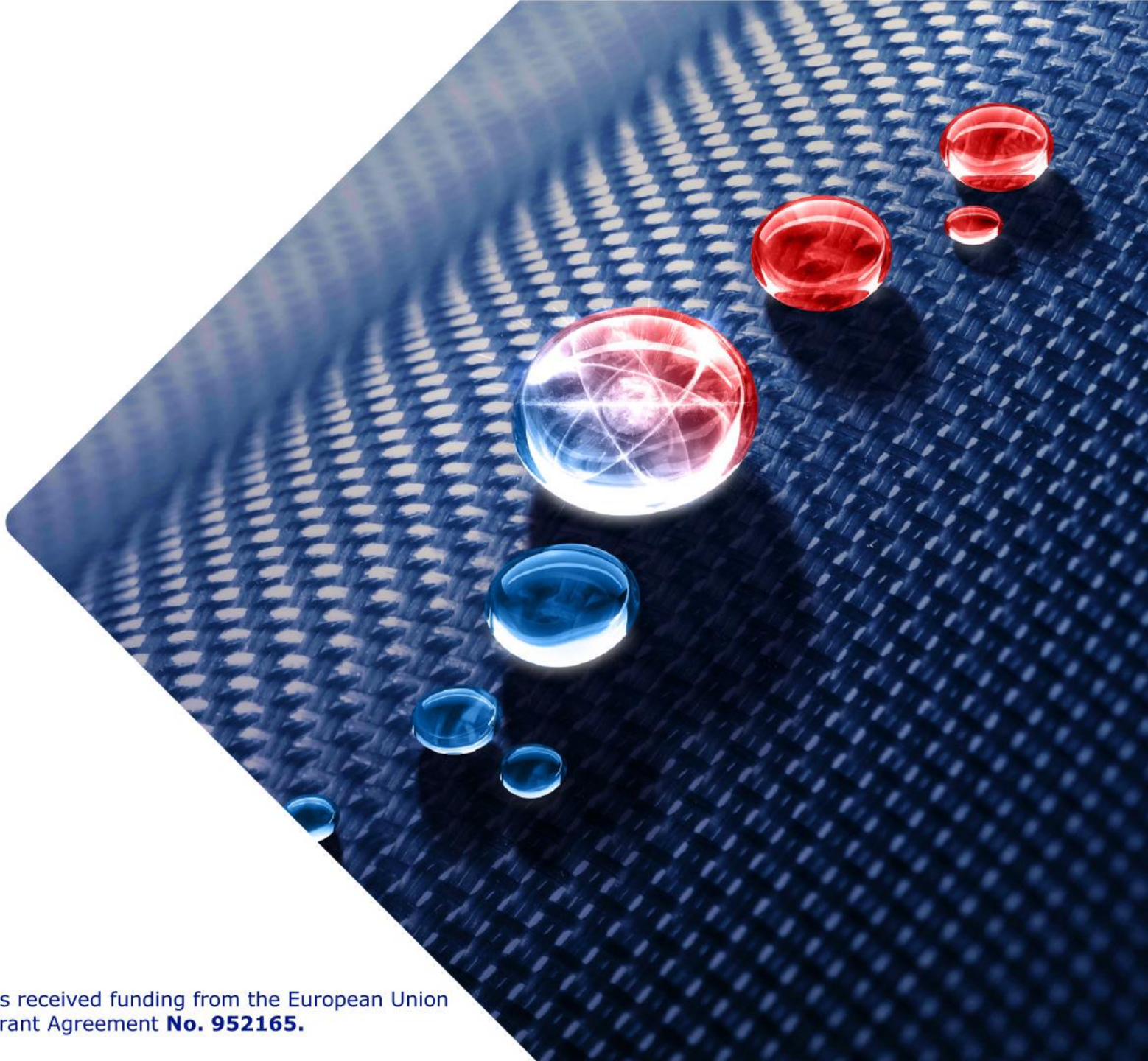# RECENT HPC EVOLUTIONS, LESSONS FROM TREX CODES

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CPU: INTEL, AMD, ARM

Smooth evolution : more FU, more ports, more memory channels, larger caches, etc….. Better Out of Order and memory hierarchy

Some innovations:

- Support for FP16

- Heterogeneous cores: Performance Cores, Efficiency cores (Alder Lake)

- AMX: matrix operations (FP16 and Integer)

GPU: NVIDIA, INTEL, AMD

Only early access to AMD and INTEL GPU

- Shared memory between GPUs

- Still waiting for shared memory between CPU and GPU: AMD has some partial solutions working.

LLVM

1. **Major industry players are now relying on LLVM:** INTEL, AMD, ARM, NVIDIA

2. **Be cautious**: LLVM does not mean that all of the modules are open source!! Proprietary solutions are embedded into LLVM: backend and also Front End Fortran

3. **GOOD NEWS:** easy to integrate new technology. For example, VERIFICARLO (Numerical Accuracy tool) is fully integrated in LLVM

GPU/SIMD programming

A lot of alternatives to proprietary CUDA: more or less open (DPC++, HIP, etc...), standard (OpenMP)

SIMD directives available in OpenMP

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1. **Poorly structured arrays :** having well structured array is essential for vectorization

2. **Loops with low iteration:** unfortunately, compiler offer very little support for such cases

3. **Opportunities for developing new tools: generate specialized code variants SISSA**

4. **Deal with large I/O**

➢ TREX web site: https://trex-coe.eu

➢ TREXIO: https://github.com/trex-coe/trexio

➢ QMCkl: https://github.com/trex-coe/qmckl

➢ QMCkl documentation: https://trex-coe.github.io/qmckl

➢ MAQAO: http://www.maqao.org

➢ Verificarlo: https://github.com/verificarlo/verificarlo