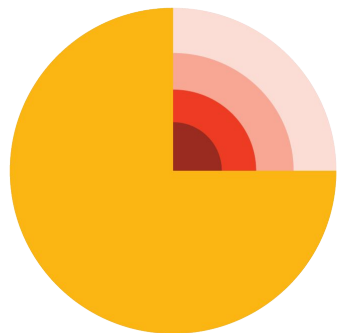




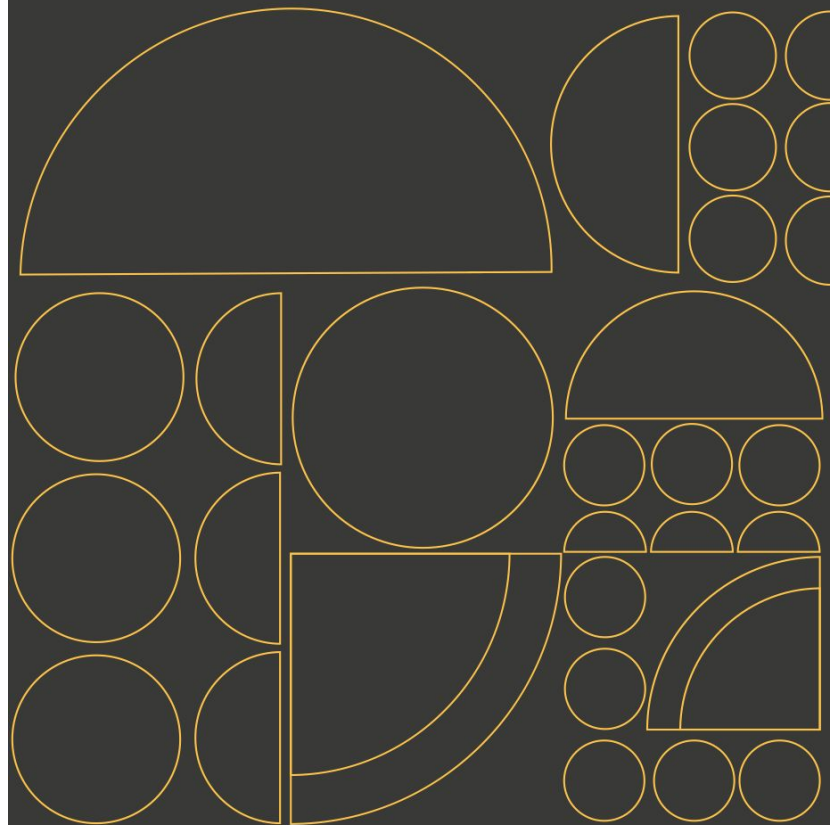
ChEESE



Mario Wille (TUM), Michael Bader (TUM)



Project funded by EuroHPC under the grant agreement No 101093038.



Contributions to WP2 (PPC)

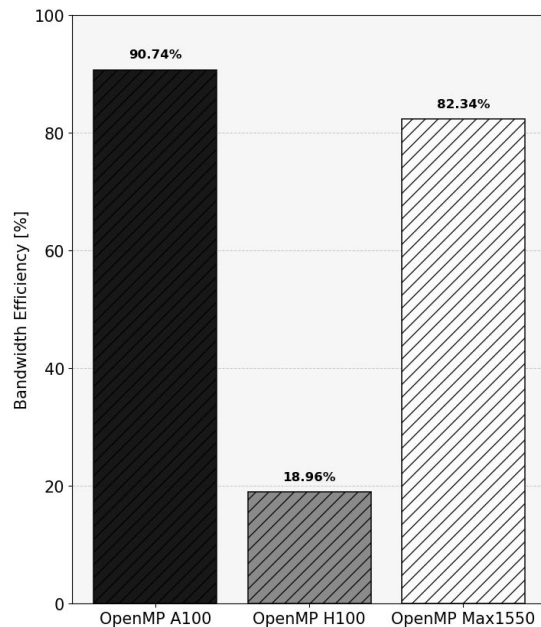
- Porting of finite volume kernels (limiter) to the GPU is finished ✓
- Porting of ADER-DG is ongoing (partially finished for OpenMP)¹ ⌚

GPU Programming Model	ADER-DG (linear + non-linear)	Finite Volume (Limiter)
OpenMP	✓	✓
SYCL	⌚	✓
stdpar	Not planned	✓
CUDA/HIP	Not planned	✓

¹ADER-DG kernels have been completely refactored after first code audit

Contributions to WP2 (PPC)

- Evaluation of kernel performance using ExaHyPE mini-app¹ (WP3?)
- Aiming for MaxPerf using analytical performance models on single GPU

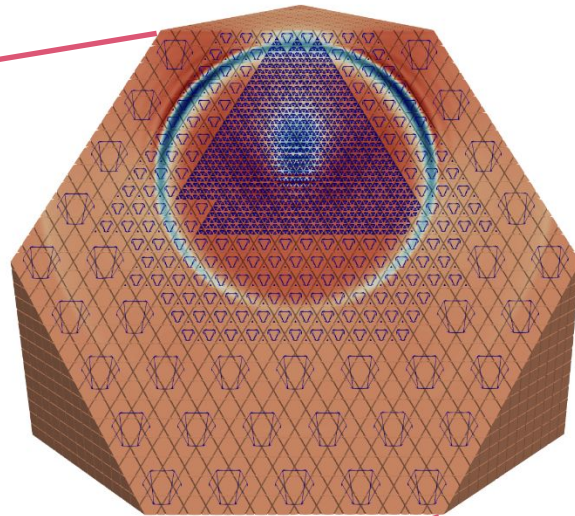
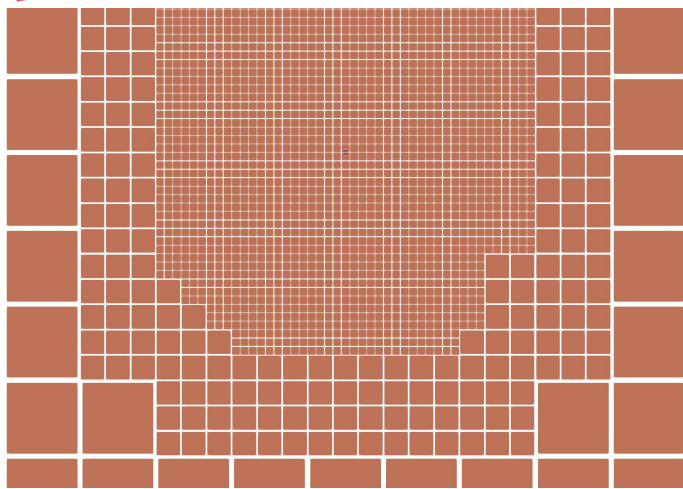


Hardware Platform	Code Support/Toolchain
Leonardo (A100, 2000 GB/s)	NVHPC, LLVM Clang, oneAPI + Codeplay
LUMI (MI250X, 3200 GB/s)	AMDClang, oneAPI + Codeplay (not tested yet)
Claix (H100, 2400 GB/s)	NVHPC, LLVM Clang
SuperMUC-NG Phase 2 (Max1550, 3276.8 GB/s)	Intel oneAPI

¹Respective paper is planned

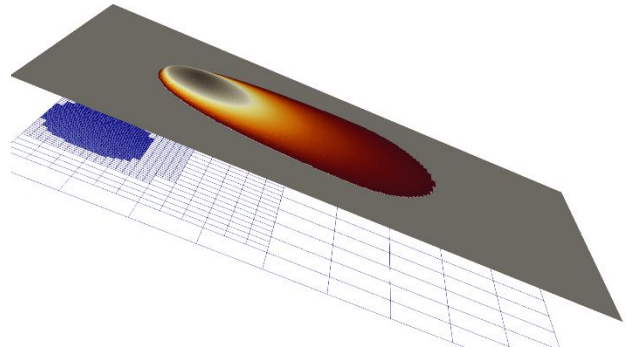
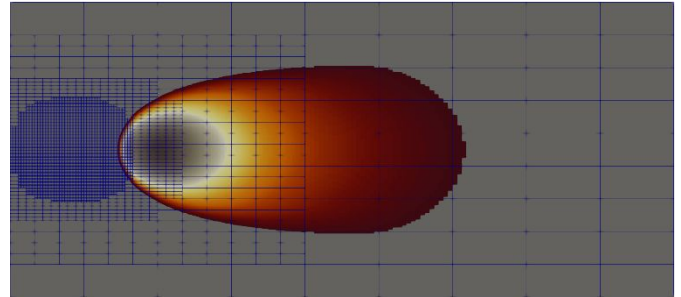
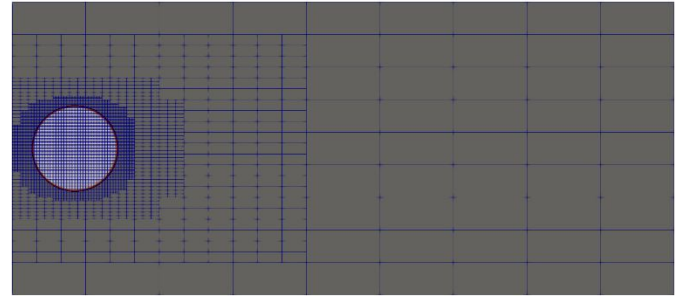
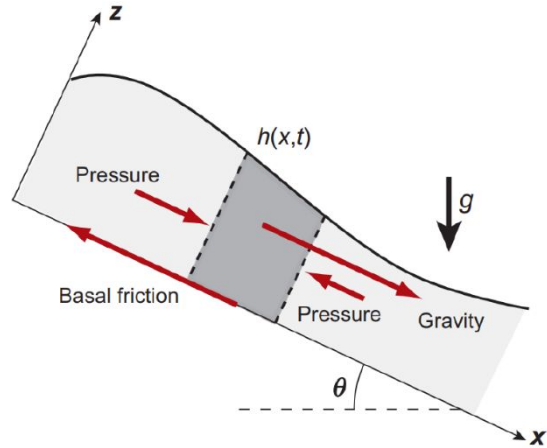
Contributions to PD 1 / SC 1.3

- ExaSeis utilizes refactored ADER-DG kernels ✓
- Curvilinear grids ⌚
- Dynamic rupture ⌚



Contributions to PD 4 / SC 4.1

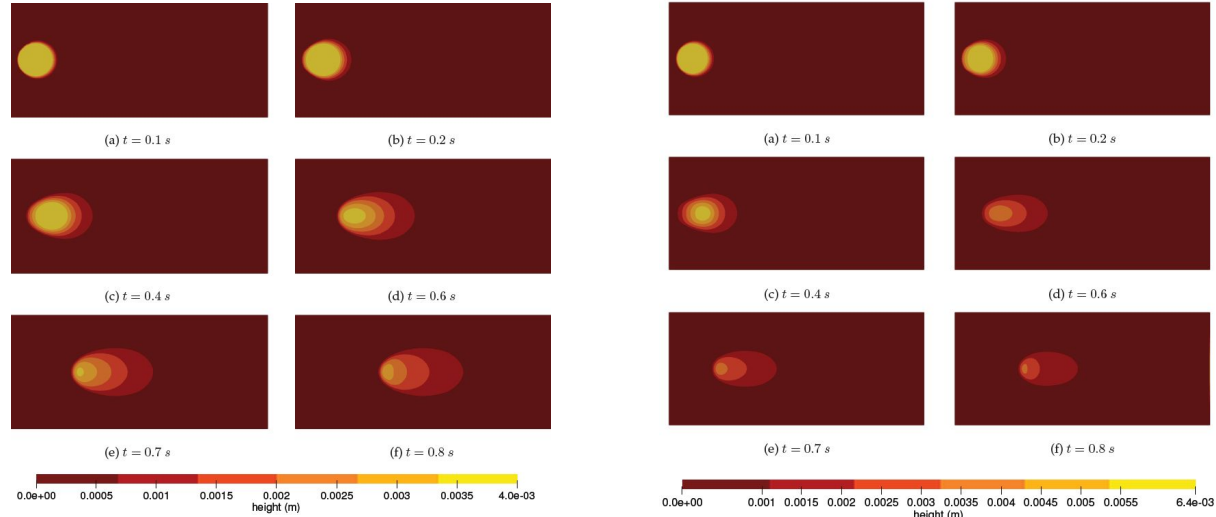
- Landslide model on inclined plane ✓
- Friction law for granular material flow ✓
- Topographic effects ⌚
- Coupling with water body (tsunami) ⌚



Contributions to PD 4 / SC 4.1

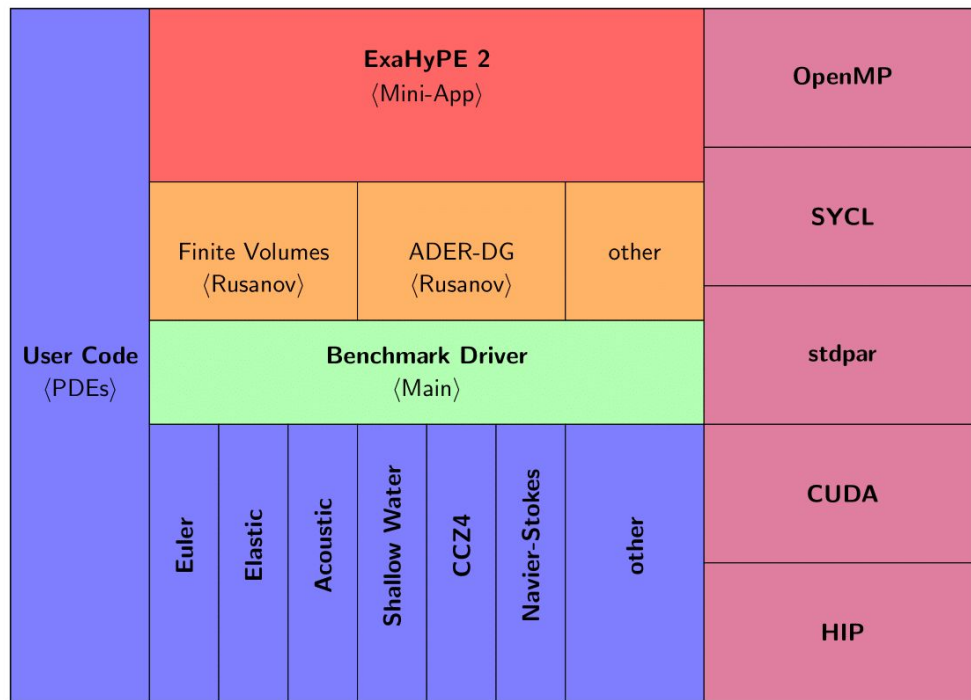
$$\frac{\partial(h\bar{u})}{\partial t} + \nabla \cdot (\chi h\bar{u} \otimes \bar{u}) + \nabla \cdot \left(\frac{1}{2}gh^2 \cos \theta \right) = gh\mathbf{S} + \frac{1}{\rho} \nabla \cdot (h\bar{\tau})$$

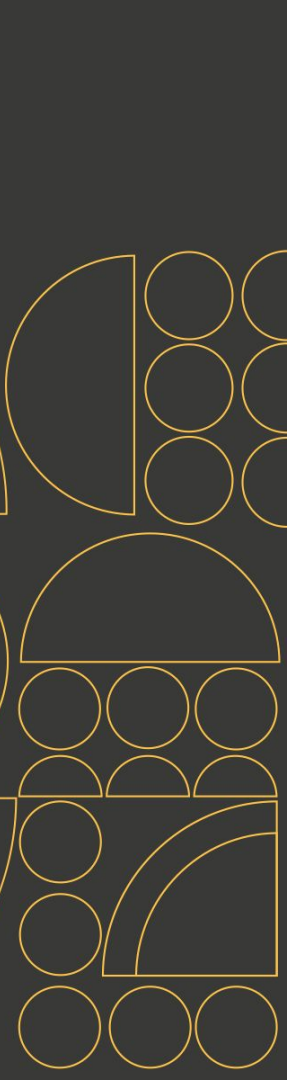
$$\mathbf{S} = \begin{pmatrix} 0 \\ gh \cos \theta - \mu(h, Fr) \frac{\bar{u}}{\sqrt{\bar{u}^2 + \bar{v}^2}} hg \cos \theta \\ -\mu(h, Fr) \frac{\bar{v}}{\sqrt{\bar{u}^2 + \bar{v}^2}} hg \cos \theta \end{pmatrix}, \quad \mu(h, Fr) = \mu_{\text{stop}} \left(h \frac{\beta}{Fr} \right)$$



Comparison of different granular materials: Sand on the left, carborundum on the right

Mini-ExaHyPE



A decorative vertical bar on the left side of the slide, featuring a dark grey background with yellow geometric patterns including circles, semi-circles, and arcs.

Code Audit

- Extended code audit finished¹
- Most critical performance bottleneck: Overhead in task orchestration
- Major performance bottleneck: Load balancing
- Multiple several fixes for minor bottlenecks have already been implemented
- Continuation via performance advisory study:
 - Compute POP metrics automatically in CI pipeline

¹<https://co-design.pop-coe.eu/reports/POP3-AR-005-ExaHyPE2.html>

Other relevant technical contributions

- CI pipeline is fully operational on the COSMA cluster in Durham:
 - Can scale from 1 to N nodes
 - Can be ported to different clusters
- Apptainer and Docker images are available for a variety of toolchains¹
- Spack package is partially finished



¹<https://hub.docker.com/u/peanoframework>