**Title:** Towards an Exascale-ready Mini-app for Smooth Particle Hydrodynamics

**Domain:** Computer Science, Applied Mathematics

**Authors:** Florina M. Ciorba1, Lucio Mayer2, Rubén Cabezon1, David Imbert3, Danilo Guerrera1, Aurélien Cavelan1, Darren Reed2, Jean-Guillaume Piccinali4,

Ioana Banicescu5, Domingo Garciá-Senz6, Thomas Quinn7

1: University of Basel, Switzerland

2: University of Zurich, Switzerland

3: NEXTFLOW Software, Nantes, France

4: Swiss National Supercomputing Center (CSCS), Lugano, Switzerland

5: Mississippi State University, MS, USA

6: Universitat Politècnica de Catalunya, Spain

7: University of Washington in Seattle, WA, USA

The smooth particle hydrodynamics (SPH) technique is a purely Lagrangian method, used in numerical simulations of fluids in astrophysics and computational fluid dynamics, with no subjacent mesh. SPH simulations represent computationally demanding calculations. Therefore, trade-offs are made between temporal and spatial scales, resolution, dimensionality (3-D or 2-D), and approximated versions of the physics involved. The parallelization of SPH codes is not trivial due to their boundless nature and the absence of a structured particle grid.

This poster presents insights into the current performance and functionalities of three SPH implementations of the SPH-EXA PASC project[[1]](#footnote-1): SPHYNX[[2]](#footnote-2), ChaNGa[[3]](#footnote-3), and SPH-flow[[4]](#footnote-4). The insights are obtained by implementation (configuration and extension of the original code base), execution, evaluation, and analysis on two modern HPC systems (Piz Daint[[5]](#footnote-5) and miniHPC[[6]](#footnote-6)), for a common test case: 3D rotating square patch[[7]](#footnote-7) with 1M particles.

The performance of these codes is negatively impacted by factors, such as multiple time-stepping and gravity. Therefore, the goal is to extrapolate their common basic SPH features, which are consolidated in a fully optimized, Exascale-ready, MPI+X, pure-SPH, mini-app. The SPH mini-app will integrate further specific physics models.

1. https://www.pasc-ch.org/projects/2017-2020/sph-exa/ [↑](#footnote-ref-1)
2. https://astro.physik.unibas.ch/people/ruben-cabezon/sphynx.html [↑](#footnote-ref-2)
3. http://faculty.washington.edu/trq/hpcc/tools/changa.html [↑](#footnote-ref-3)
4. http://www.sph-flow.com [↑](#footnote-ref-4)
5. https://www.cscs.ch/computers/piz-daint/ [↑](#footnote-ref-5)
6. https://wiki.dmi.unibas.ch/doku.php?id=fbi:hpc:minihpc\_system&s[]=minihpc [↑](#footnote-ref-6)
7. http://padis.uniroma1.it/handle/10805/688 (2D version) [↑](#footnote-ref-7)