



# SPH With **I**nter-dependent **F**ine-grained **T**asking

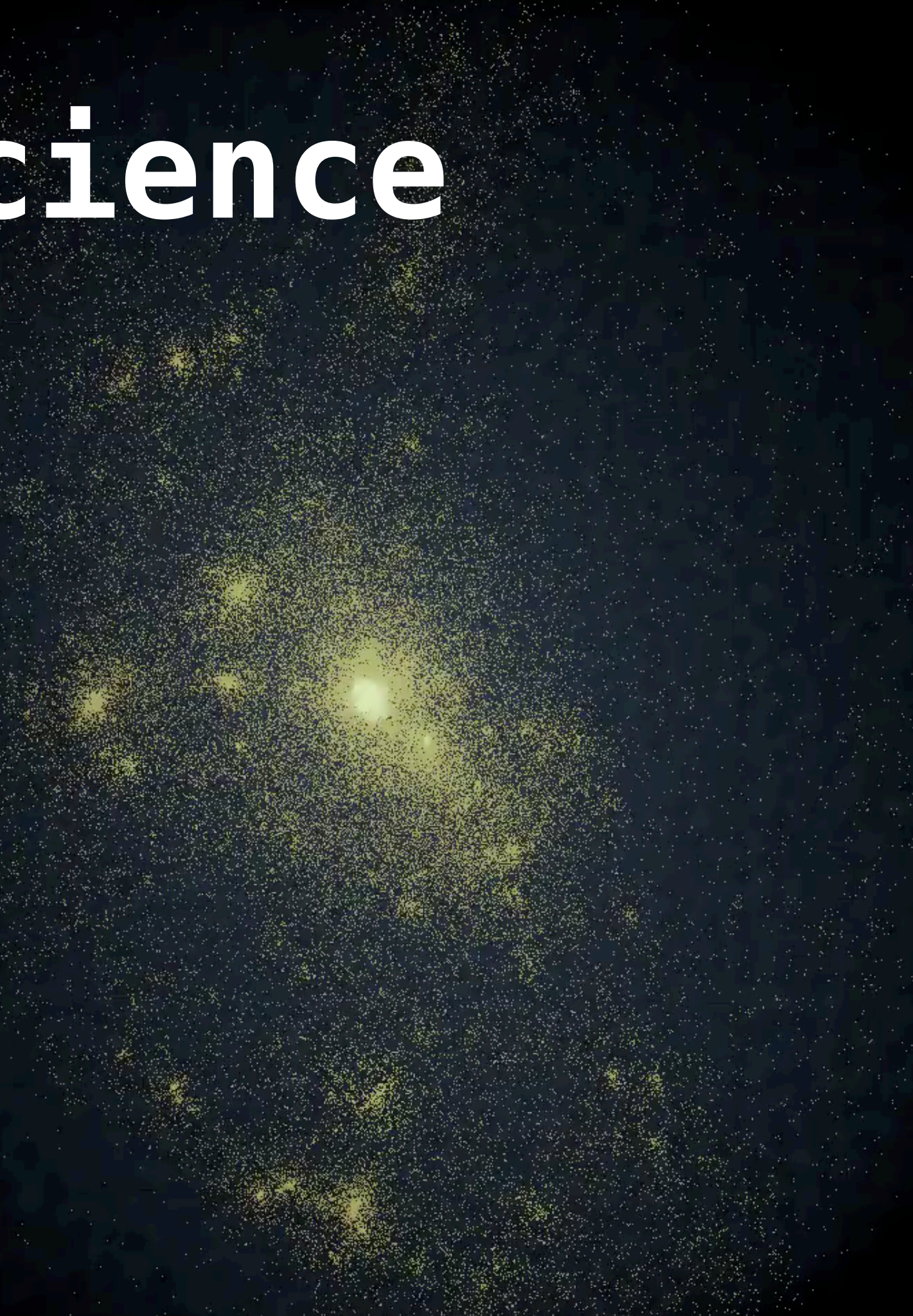
Matthieu Schaller  
Aidan Chalk  
Loic Hausammann

Josh Borrow  
**Christopher Bignamini**  
**Aryan Eftekhari**



# SWIFT: Science

- We are trying to solve:  
large-scale structure  
formation in the Universe!  
How, why, and when?
- Scientific driver for  
algorithm: SPH + gravity.  
Hydro and gravity  
dominate the forces on  
matter in the Universe and  
hence are the most  
important to consider...



# Initial Profile

- Very poor, ‘obvious’ algorithms with e.g.  $n^2$  memory reads per particle for calculating density.
- Example: `doself_density`: calculates the density inside a ‘cell’ by interacting each particle with all of the others in turn.



# Goals For the Week

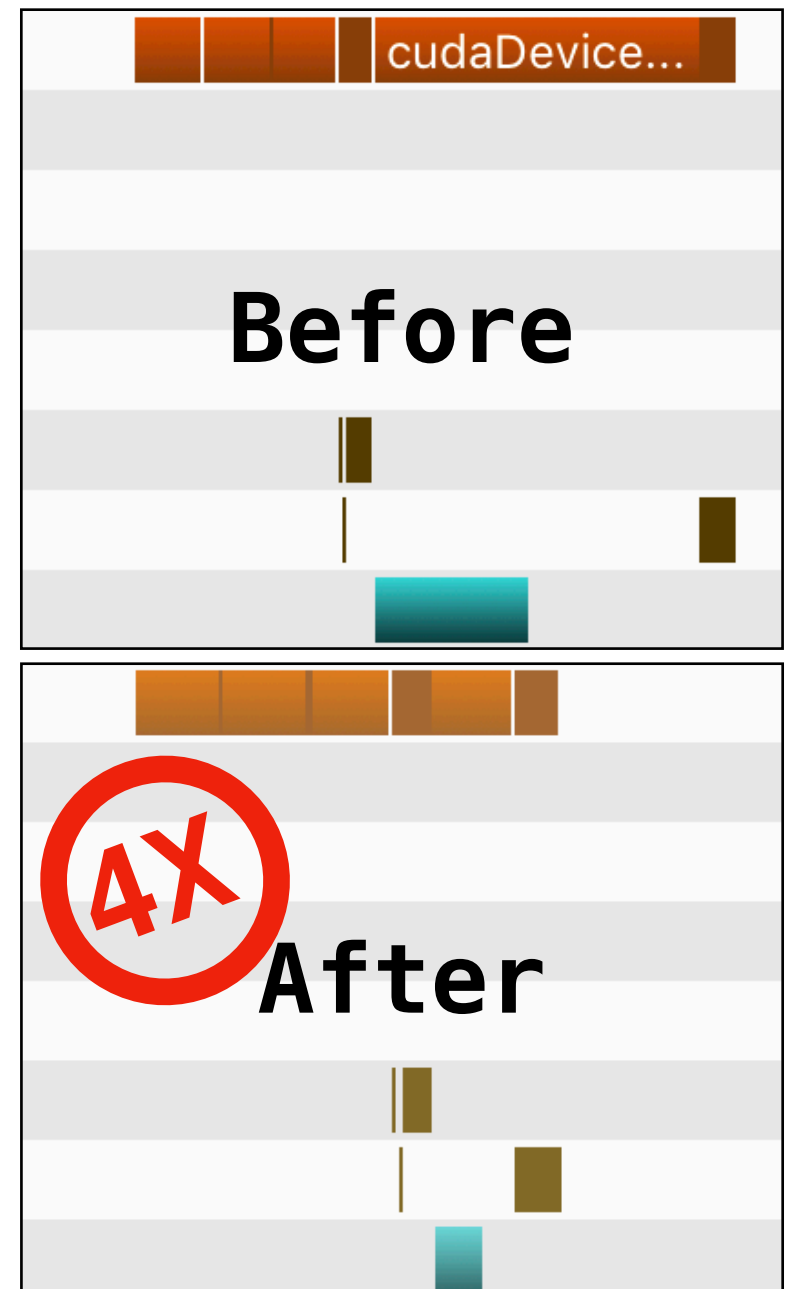
- Improve the efficiency of the core kernels by looking at thread usage and register pressure. Low flop/byte likely a limitation.
- Use CUDA as our runtime scheduler uses this language.

# Evolution and Strategy

- Needed to write individual test kernels for performance profiling as our 'MegaKernel™' is not the best for this
- Had a lot of issues with hdf5 on the first day (1.10.x) but this was solved by reverting to 1.8.16 and manually linking
- Needed to learn how to profile correctly and use nvprof, nvvp, etc. as most of the team are relatively new to GPU stuff...

# Results

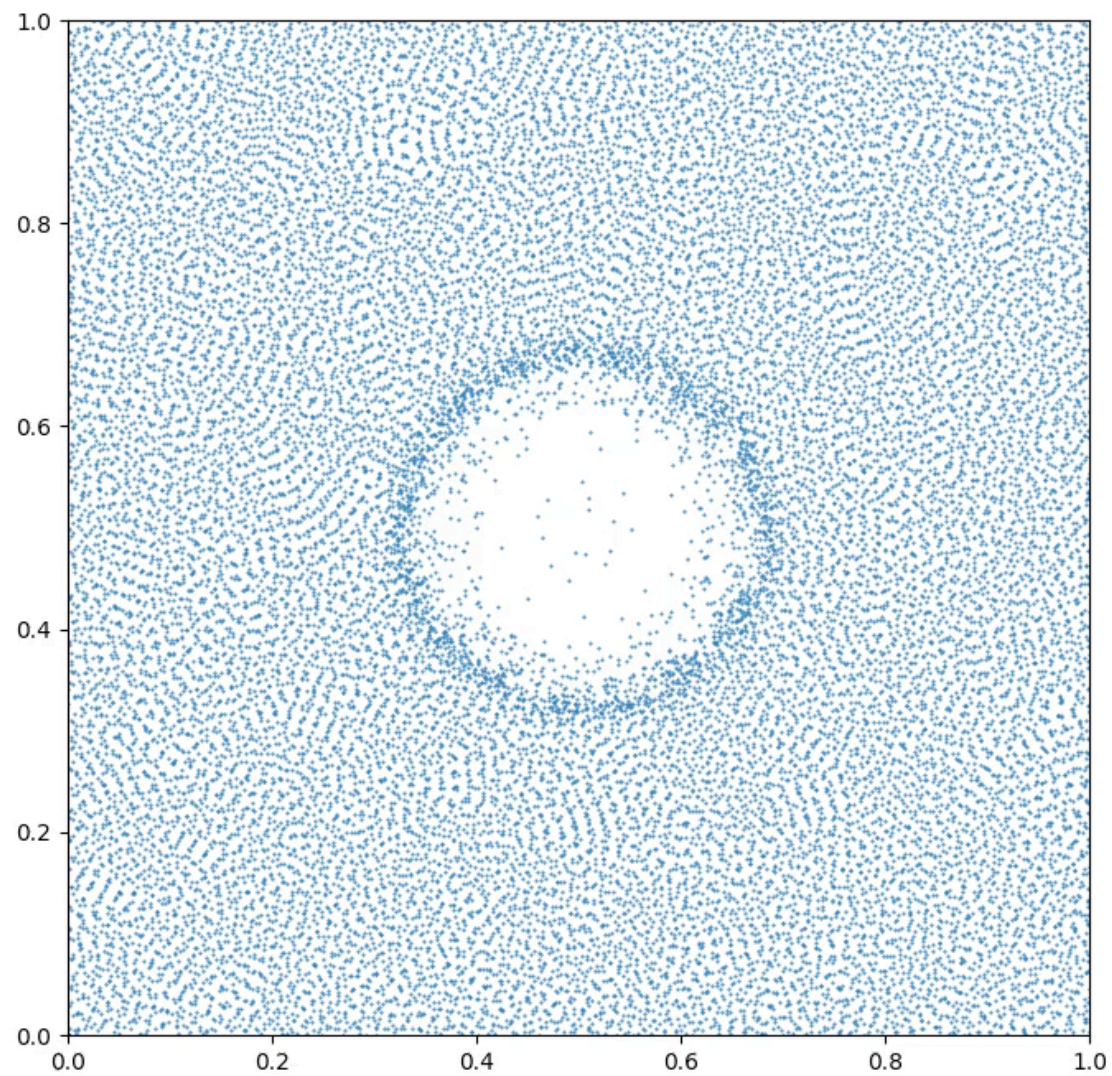
- Speedup of 4x (100x?) on `doself_density` by using better caching
- Learned a *lot* about profiling
- Our Kernel is still *very* young and so very buggy, most of the week by core team were spent on fixing these bugs.



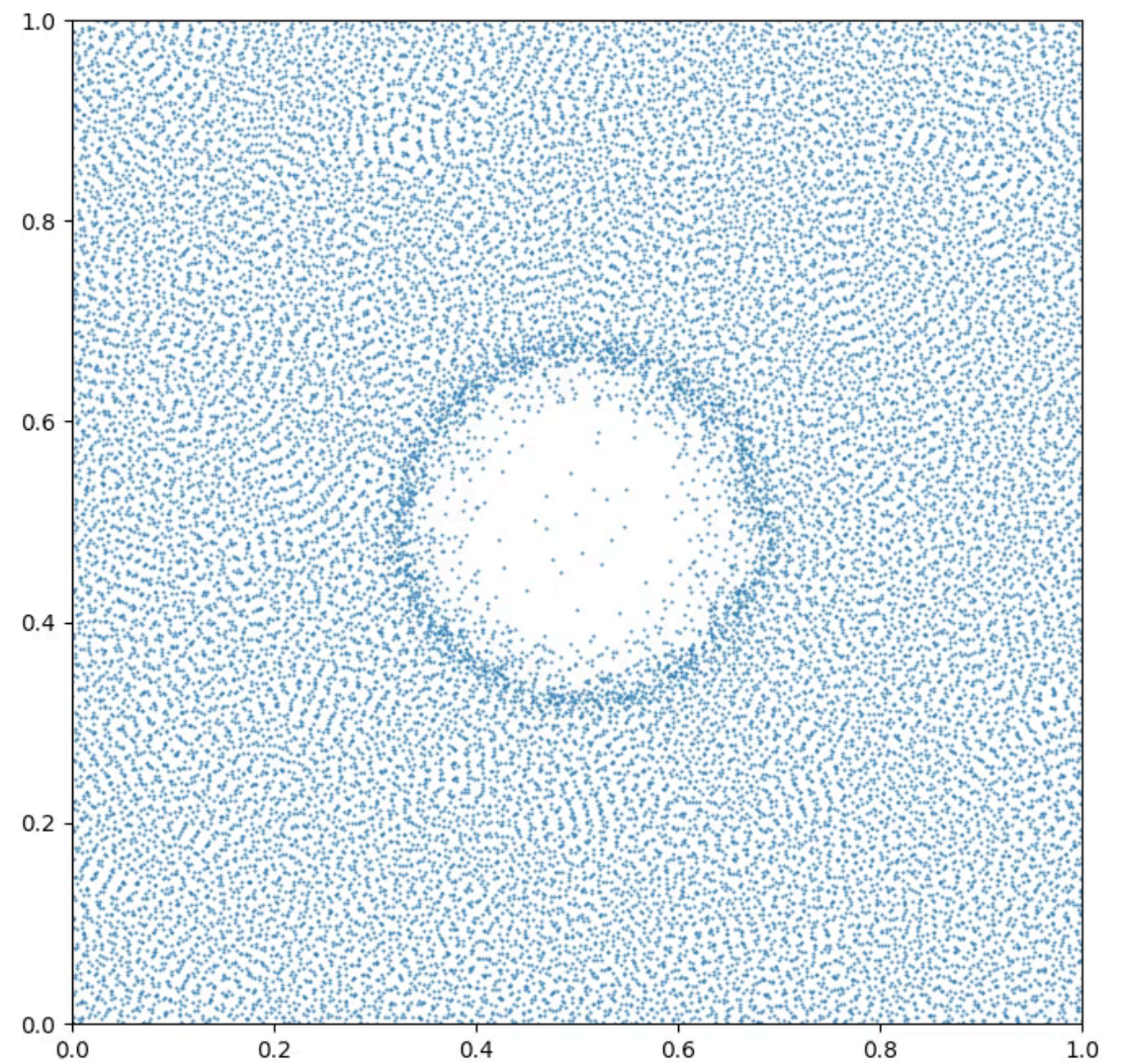


# Results

## CPU



## GPU



# Issues/Suggestions

- Would be good for NVIDIA profiling tools to be able to inspect kernels in an easier fashion. (e.g. allow for individual device function analytics)
- Need better visualisation tools (totally our fault...)
- Very odd bug where we hang on Daint **only** but not in cuda-gdb or cuda-memcheck.
- hdf5 on CRAY systems!!!



# Was it worth it?

- Yes!
- We have learned a lot this week, especially junior members of the team.
- **We will definitely be continuing development** and are looking forward to continuing to work with CSCS.

# Contacts

- Code all freely available at <https://gitlab.cosma.dur.ac.uk/swift/swiftsim>
- General website at <http://www.swiftsim.com>  
(improvements coming soon...) along with all the papers
- **@SwiftSimulation**