



## k-Wave Performance Assessment Summary

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**Initial analysis of k-Wave identified a major imbalance between the interior and exterior processes of its three-dimensional decomposition, which the developers could subsequently rectify and thereby reduce execution time by more than 50%.**

Large amounts of both MPI and OpenMP synchronisation time were identified by the initial audit. Interior processes of the 3D grid decomposition were found to need to wait in MPI communication with exterior processes, while the latter had large amounts of OpenMP synchronisation time in many more small and poorly-balanced parallel loops. Although these exterior processes had fewer grid cells, they had a larger FFT base which was much less efficient. With this insight, the developers were quickly able to apply a periodic domain with identical halo zones for each MPI rank such that the exterior processes became balanced with the interior processes.

k-Wave is an open-source toolbox for time domain acoustic and ultrasound simulations in complex and tissue-realistic media. It is written using C++ parallelised with MPI+OpenMP (and CUDA), and developed by University College London and Brno University of Technology.

A full technical report can be found at

[https://pop-coe.eu/sites/default/files/pop\\_files/pop-ar-kwave.pdf](https://pop-coe.eu/sites/default/files/pop_files/pop-ar-kwave.pdf)

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