# Efficient AMG preconditioners on clusters of GPUs

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**Abstract.** Many scientific applications require the solution of large and
sparse linear systems of equations using iterative methods, this opera-
tion accounting for a large percentage of the computing time. In these
cases the choice of the preconditioner is crucial for the convergence of
the method. Given the broad range of applications, great effort has been
put in the development of efficient preconditioners ensuring algorithmic
scalability: in this sense multigrid methods have been proved to be partic-
ularly promising. Additionally, the advent of GPUs, now found in many
of the fastest supercomputers, poses the problem of efficient implemen-
tation of these algorithms on highly parallel architectures; this is made
more difficult by the fact that the solution of sparse triangular systems, a
common kernel in many types of preconditioners, is extremely inefficient
on GPUs.

In this paper, we will use the PSBLAS and MLD2P4 libraries to explore
the various issues that affect efficiency of multilevel preconditioners on
GPUs, both in terms of execution speed and exploitation of computa-
tional cores, as well as the algorithmic efficiency in guaranteeing conver-
gence to solution in a number of iterations independent of the degree
of parallelism. These issues are investigated in the context of linear sys-
tems arising from groundwater modelling application of the filtration of
3D incompressible single-phase flows through anisotropic porous media.

**Keywords:**