Efficient Implementation of High-order Discontinuous Galerkin Methods

P. Bastian[1], **D. Kempf**[2], **E. H. Müller**[3], **S. Müthing**[4] **and M. Piatkowski**[5]

Abstract: Unleashing the high-performance advertised by current supercomputers provides quite a challenge for finite element methods. The traditional approach of setting up a sparse linear system using a sparse matrix format and solving this system by some preconditioned Krylov method performs typically only at a few percent of theoretical peak due to memory bandwidth limitations. Matrix-free implementation of high-order methods offers the possibility of bypassing the memory bottleneck while at the same time reducing the number of floating-point operations substantially. In this talk we present the sum factorization method applied to discontinuous Galerkin discretizations and present performance results for a convection-diffusion operator including a mostly matrix-free algebraic multigrid preconditioner. High floating point performance of up to 60% peak performance and excellent scalability within a single node and across nodes is demonstrated.

[1,2,4,5] Interdisciplinary Center for Scientific Computing
University of Heidelberg
Im Neuenheimer Feld 205, 69120 Heidelberg, Germany
peter.bastian@iwr.uni-heidelberg.de

[3] Department of Mathematical Sciences
University of Bath
Claverton Down, Bath BA2 7AY, United Kingdom