



HAL
open science

Exploiting the Nested Block Structure of DG Matrices: a Block ILU Preconditioner with Deflation and a Spectral Two-Level Strategy

Paulien Van Slingerland, Kees Vuik

► **To cite this version:**

Paulien Van Slingerland, Kees Vuik. Exploiting the Nested Block Structure of DG Matrices: a Block ILU Preconditioner with Deflation and a Spectral Two-Level Strategy. International Conference On Preconditioning Techniques For Scientific And Industrial Applications, Preconditioning 2011, May 2011, Bordeaux, France. inria-00581565

HAL Id: inria-00581565

<https://inria.hal.science/inria-00581565>

Submitted on 31 Mar 2011

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Exploiting the Nested Block Structure of DG Matrices: a Block ILU Preconditioner with Deflation and a Spectral Two-Level Strategy

List of authors:

P. van Slingerland ¹

C. Vuik ²

The main advantages of Discontinuous Galerkin (DG) discretizations for elliptic problems are their flexibility in handling non-matching grids and in designing *hp*-refinement strategies. However, an important drawback is that the resulting linear systems are usually large (due to the large number of degrees of freedom) and ill-conditioned. As a consequence, standard Krylov methods typically require too much computational time to solve these systems.

To increase the practical applicability of DG discretizations, we propose a preconditioning technique that is based on a nested block incomplete LU factorization. Earlier, this type of preconditioner was applied successfully in the context of finite difference discretizations for oil reservoir simulation [1, 2]. Here, we combine their ideas with deflation [3] and a spectral two-level strategy to obtain a preconditioner that is suitable for our application, and that efficiently exploits the nested block structure of the coefficient matrix. Various symmetric test cases demonstrate that this technique can lead to uniform convergence of the conjugate gradient method.

References

- [1] J. R. Appleyard and I. M. Cheshire. Nested factorisation. paper SPE 12264 presented at the SPE 1983 Reservoir Simulation Symposium, San Francisco, CA., 1983.
- [2] J. A. Meijerink. Iterative methods for the solution of linear equations based on incomplete block factorization of the matrix. paper SPE 12262 presented at the SPE 1983 Reservoir Simulation Symposium, San Francisco, CA., 1983.
- [3] C. Vuik, A. Segal, and J. A. Meijerink. An Efficient Preconditioned CG Method for the Solution of a Class of Layered Problems with Extreme Contrasts in the Coefficients. *Journal of Computational Physics*, 152:385–403, 1999.

¹Delft University of Technology, Delft Institute of Applied Mathematics, Mekelweg 4, 2628 CD Delft, The Netherlands (p.vanslingerland@tudelft.nl)

²Delft University of Technology, Delft Institute of Applied Mathematics, Mekelweg 4, 2628 CD Delft, The Netherlands (c.vuik@tudelft.nl)