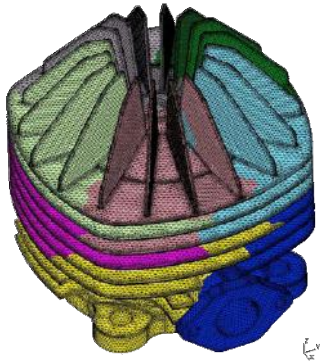
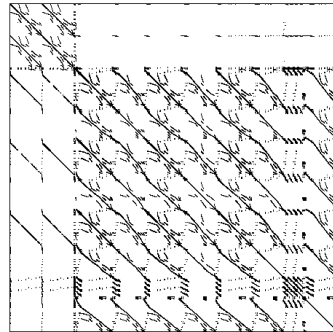


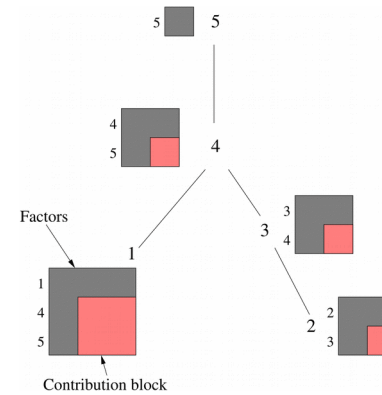
Complexity and performance of Block Low-Rank multifrontal solvers



discretized physical problem



sparse linear system
 $Ax = b$



multifrontal solver
(e.g. MUMPS)



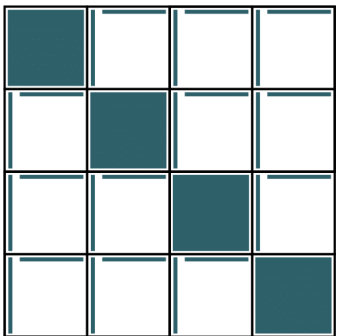
supercomputer

Often the most expensive part of numerical simulations

➔ **Objective of the thesis: reduce the cost of direct solvers**

BLR multifrontal solver

1st result: reduction of the complexity (theoretical result and experimental validation)



BLR matrix

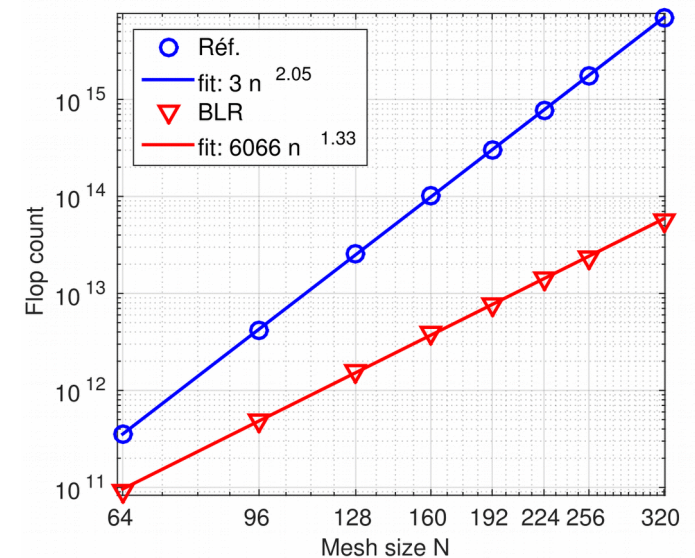
compute \mathbf{A}_ε , approximation of \mathbf{A} at precision ε

→ using \mathbf{A}_ε allows for a significant reduction of the cost of the solver in terms of both memory and cpu consumption

Recent theoretical result: **the BLR format reduces the complexity of the solver from $O(n^2)$ to $O(n^{1.33})$**

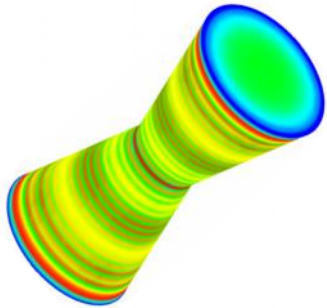
Reference:

► Amestoy et al., 2016, *On the Complexity of the Block Low-Rank Multifrontal Factorization*, under review in *SIAM SISC*



BLR multifrontal solver

2nd result: improving the solver performance on real-life problems and large numbers of cores



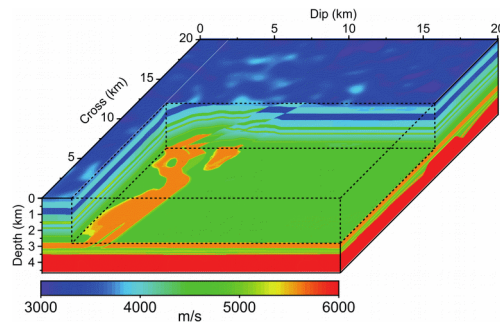
Structural mechanics

Matrix of size 8M

Requested precision: 10^{-9}

Problem	Ref.	BLR
Structural	386	131
Seismic	1017	280
Electromag.	2221	515

**Time (s) for factorization
on 900 cores**



Seismic imaging

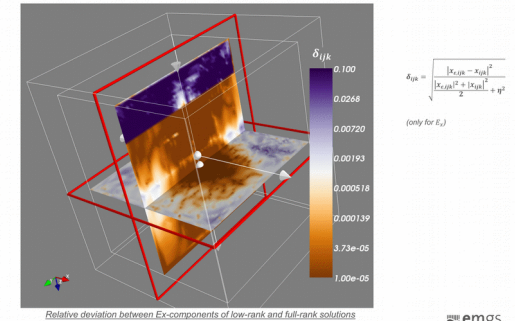
Matrix of size 17M

Requested precision: 10^{-3}

References:

- ▶ Amestoy et al., *Fast 3D frequency-domain full waveform inversion with a parallel Block Low-Rank multifrontal direct solver: application to OBC data from the North Sea*, *Geophysics*, 2016.
- ▶ Amestoy et al., *Large-scale 3D EM modeling with a Block Low-Rank multifrontal direct solver*, under review in *Geophysical Journal International*, 2016.
- ▶ Amestoy et al., *Performance and Scalability of the Multithreaded Block Low-Rank Multifrontal Factorization on Multicore Architectures*, in preparation.

E_x , BLR STRATEGY 2, IR = 0, $\epsilon_{BLR} = 10^{-7}$



30

Electromagnetism

Matrix of size 30M

Requested precision: 10^{-7}

$$\delta_{ijk} = \frac{|x_{ijk} - x_{ijk}|^2}{|x_{ijk}|^2 + |x_{ijk}|^2 + \epsilon^2}$$

(only for E_x)

emgs