

sparsix
corporation

Mathematics *empowered*

Analysis Applications

- Power Grid Modeling
- Oil Reservoir Modeling
- FEA / CFD Analysis
- Financial Markets Modeling
- Scheduling Optimization
- Pipeline Flow Optimization

Sparse Iterative Solvers

SparSol

Systems with real coefficients

LinCoS

Systems with complex coefficients

Preprocessing

- Scaling
- Reordering
- Filtration

Partitioning

- Multi-level, overlap
- METIS

Preconditioning

- Incomplete LU
- Incomplete Cholesky
- Algebraic multi-level
- Block and parallel

Iterative Methods

- BiCGStab
- MINRES
- TFQMR
- SVD
- CG

Library of optimized basic linear algebra operations

- Matrix-vector, vector-vector, custom "group" functions and more

SparSol

- Solver for systems with real coefficients
 - 200,000 lines of source code, 550 classes
 - Serial & parallel versions
- SparSol innovations:
 - New ILU type preconditioner: FILU – Fill-in Incomplete LU preconditioner
 - New Incomplete Cholesky preconditioner: IC2
 - New parallel partitioner: KWPT

LinCoS

- Solver for systems with complex coefficients
 - 40,000 lines of source code, 40 classes
 - Serial & parallel versions
- LinCoS innovations:
 - Uses ILUT type preconditioner of Yousef Saad with some modifications (mostly for parallel computing)
 - Special library for performing complex number operations

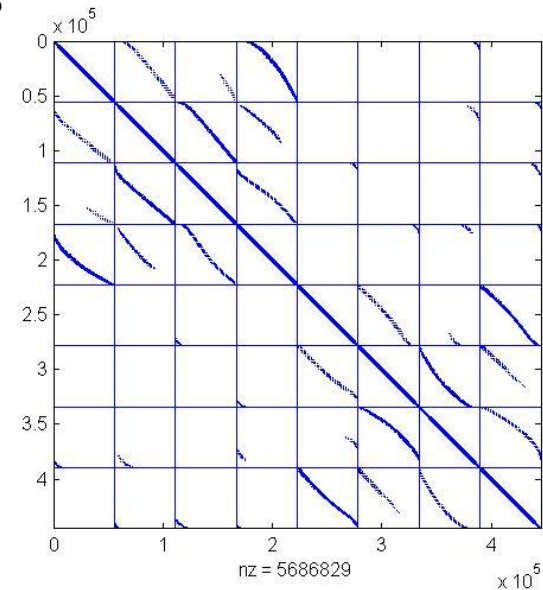
- Parallel iterative solver designed for complex linear systems
 - Linear systems arising from Helmholtz and Maxwell equations
 - Directly solves complex system, no need for equivalent real-formulated systems
- Custom internal data structures
 - Optimized for efficient computation of complex equations
 - Up to 2x faster than standard C++ `complex<double>` data structure
- Optimized for distributed computational systems (clusters)
 - 2.5x faster than best parallel, non-preconditioned iterative method
 - Scales exceptionally well - 8x-11x times faster on 8 CPU cluster
- Development finished, customer beta currently available

LinCoS – Basic Algorithms

- Serial solver includes:
 - Preconditioners: ILU0, ILUT
 - Iterative Methods: BiCGStab, TFQMR, CG
 - Glinco - optional GUI utility
- Parallel MPI solver includes:
 - Serial algorithms
 - Partitioners: Simple, external METIS
 - Parallel Preconditioners: Diagonal, One-Level Overlap
 - Both use serial preconditioners for diagonal block factorization
 - Parallel version of Iterative Methods

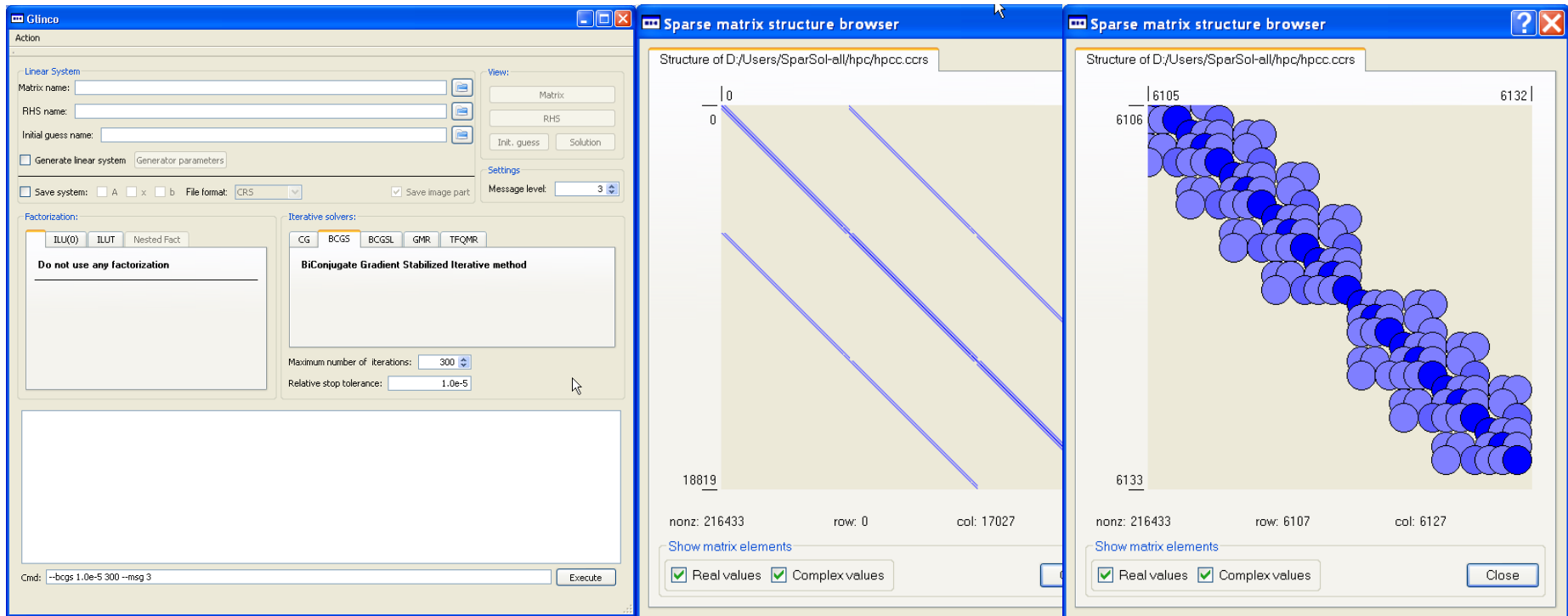
LinCoS – Partitioners

- Partitioning is critical for parallel computations. Effective partitioning requires:
 - Load-balancing
 - Minimization of inter-processor communications
- Simple Partitioner partitions a matrix into given number of strips with (almost) the same number of rows
- Metis Partitioner is an external, freely available package which implements high-quality multi-level graph partitioning minimizing the number of interface rows and edge-cuts



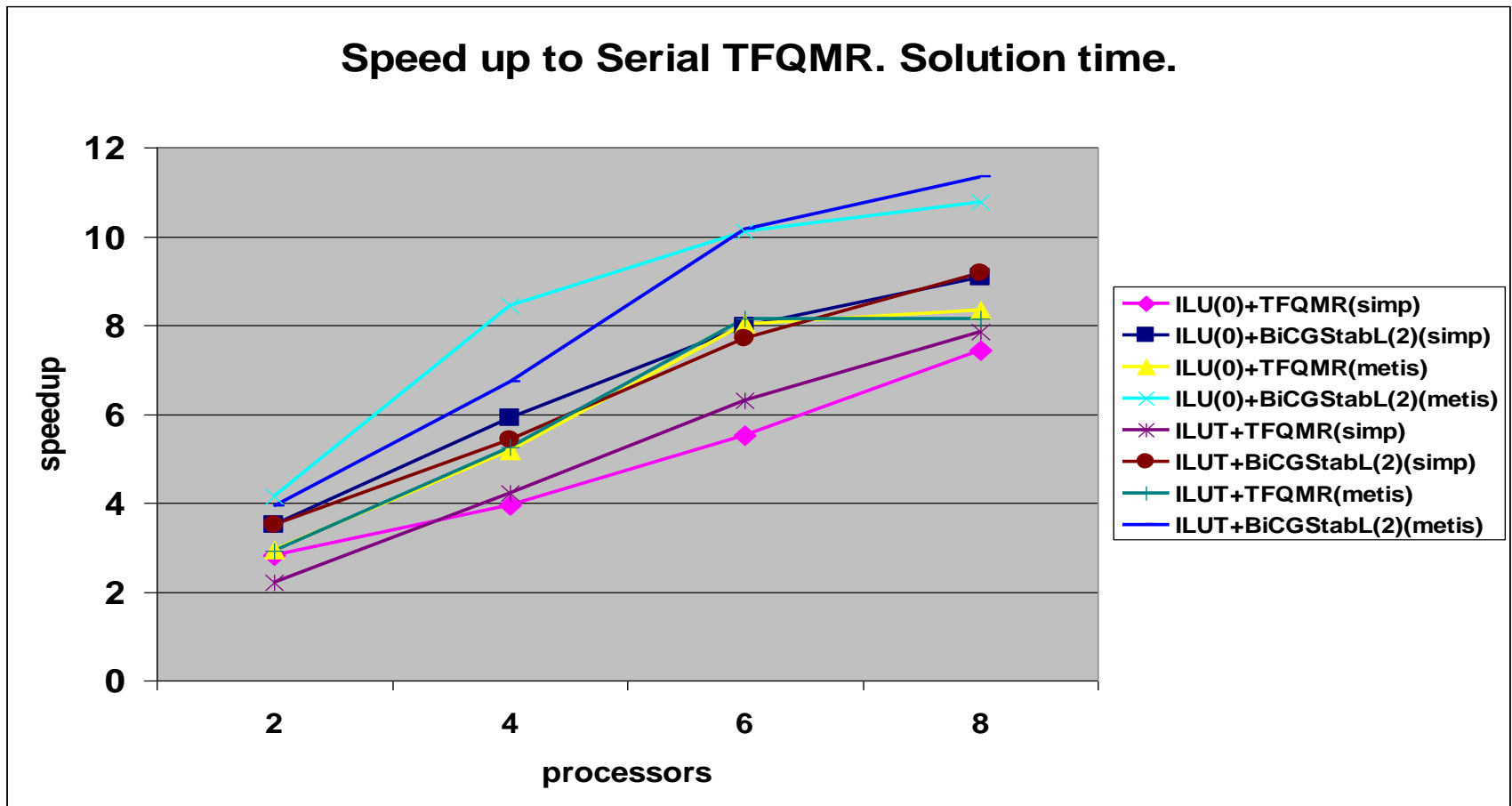
Glinco – Graphical User Interface

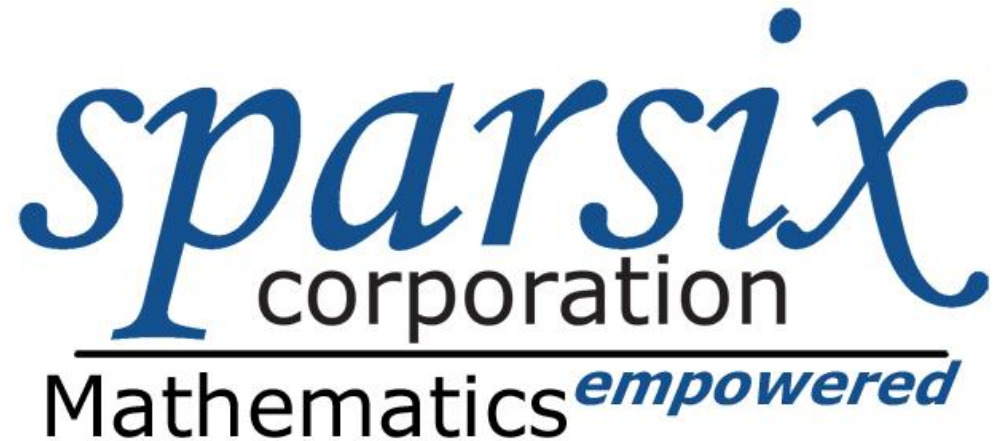
- Convenient tool which allows users to:
 - Load/store data from/to disk
 - Select correct combination of algorithms
 - Visualize matrix and vectors



LinCoS – Parallel Performance

- The plot below shows speed up of all variants of preconditioned iterative methods with respect to serial TFQMR without precondition





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