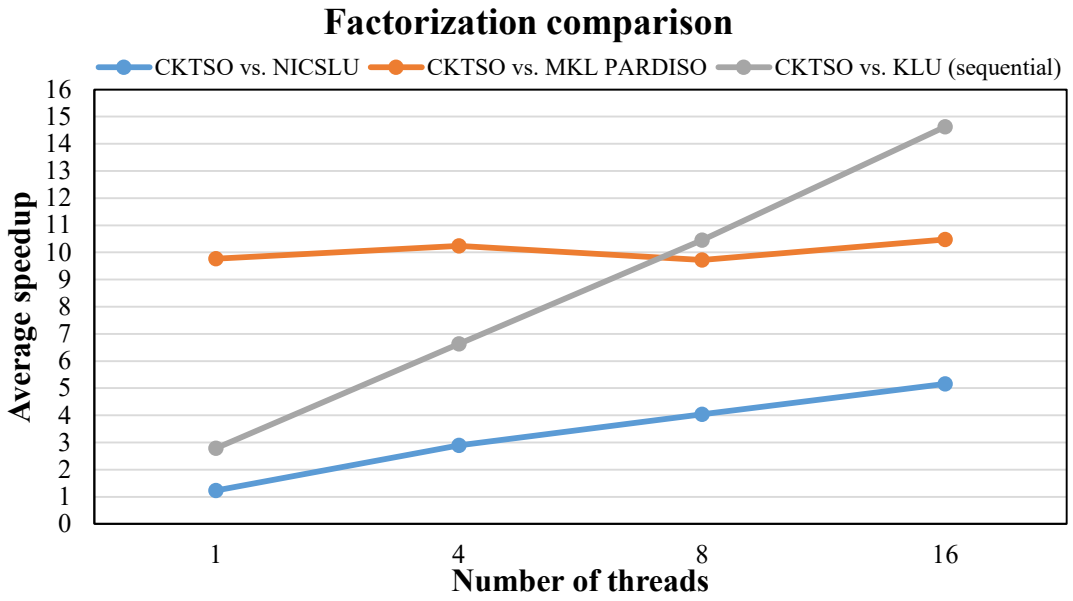
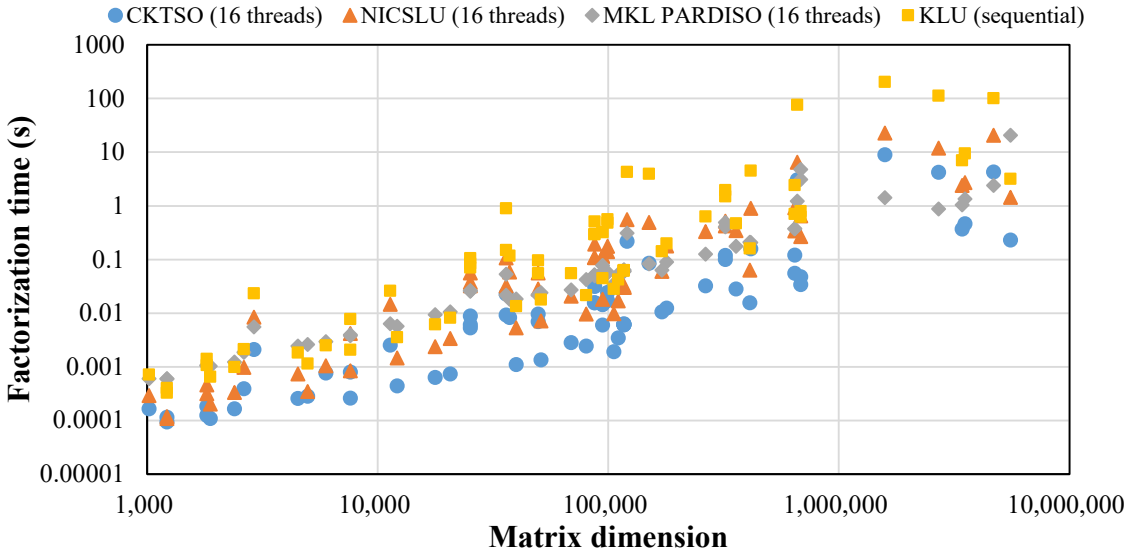
Results of CKTSO and Comparisons with Other Solvers

CKTSO (version 202205) is compared with NICSLU, Intel MKL PARDISO, KLU and two latest GPU-based solvers for circuit simulation. The hardware and software configurations for testing CPU-based solvers are listed in the following table. Note that KLU is purely sequential, and NICSLU does not have parallel solving. KLU uses the ordering results of NICSLU. The results of the two GPU-based solvers are directly extracted from their publications, as the solvers are not publicly available.

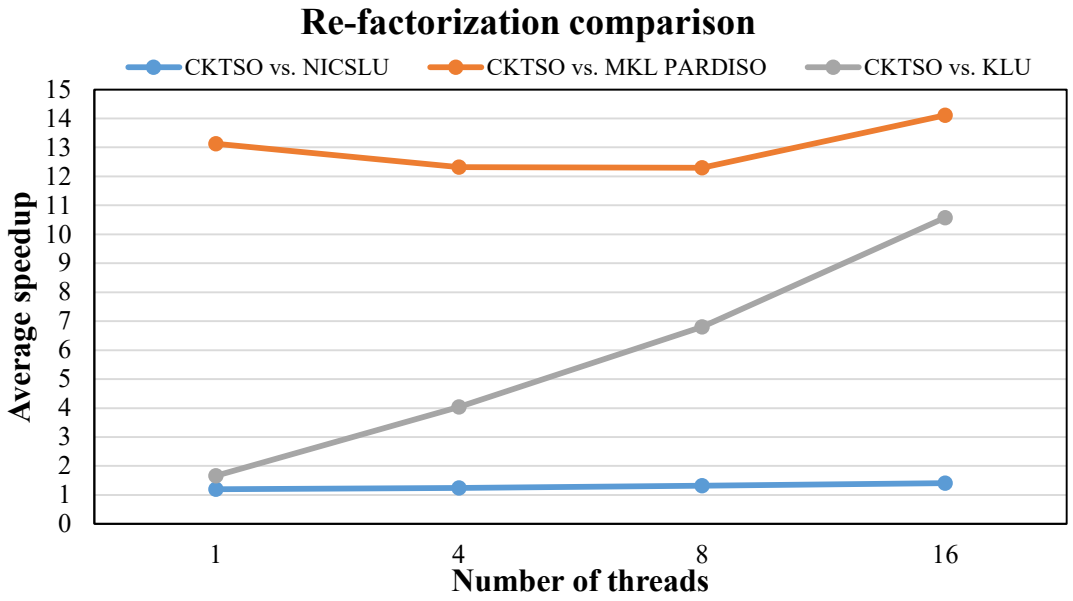
Operating system	CentOS 7.9.2009 x64
Compiler	gcc 4.8.5
CPU	Intel Xeon Gold 6130 (16 cores, 2.1GHz)
Memory	256GB
Benchmarks	66 circuit matrices from SuiteSparse Matrix Collection
Integer bitwidth	32 bits
Baselines	1) NICSLU version 202110 2) KLU version 1.3.9 3) Intel MKL PARDISO version 2022.0.2 4) GPU-SFLU [J. Zhao, Y. Wen, Y. Luo, Z. Jin, W. Liu, and Z. Zhou. SFLU: Synchronization-Free Sparse LU Factorization for Fast Circuit Simulation on GPUs. In 2021 58th ACM/IEEE Design Automation Conference (DAC). 37-42] 5) GPU-RLA [W.-K. Lee and R. Achar. GPU-Accelerated Adaptive PCBSO Mode-Based Hybrid RLA for Sparse LU Factorization in Circuit Simulation. IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems 40, 11 (2021), 2320-2330]

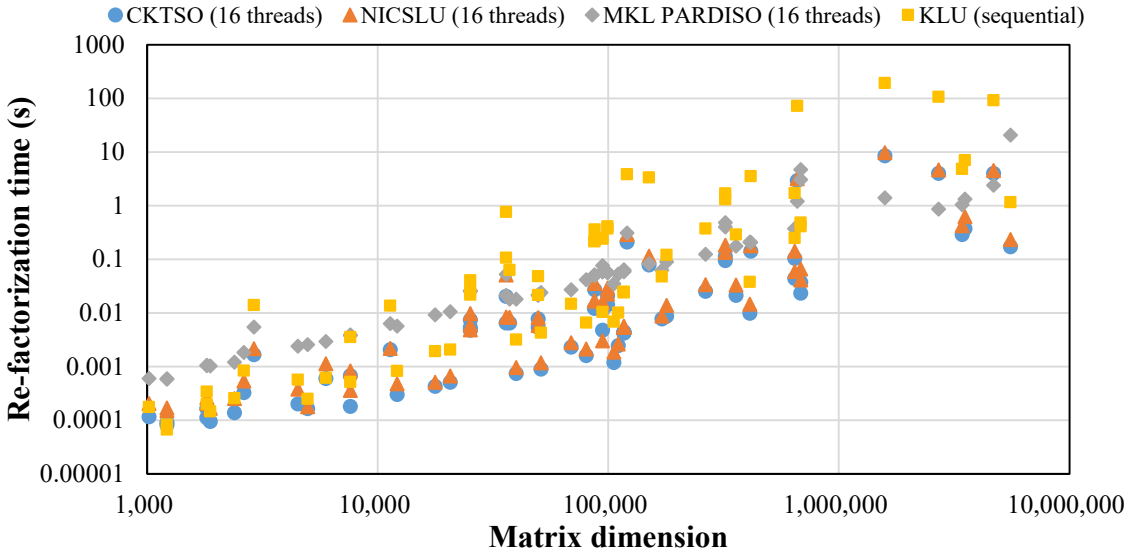
1. Factorization Performance



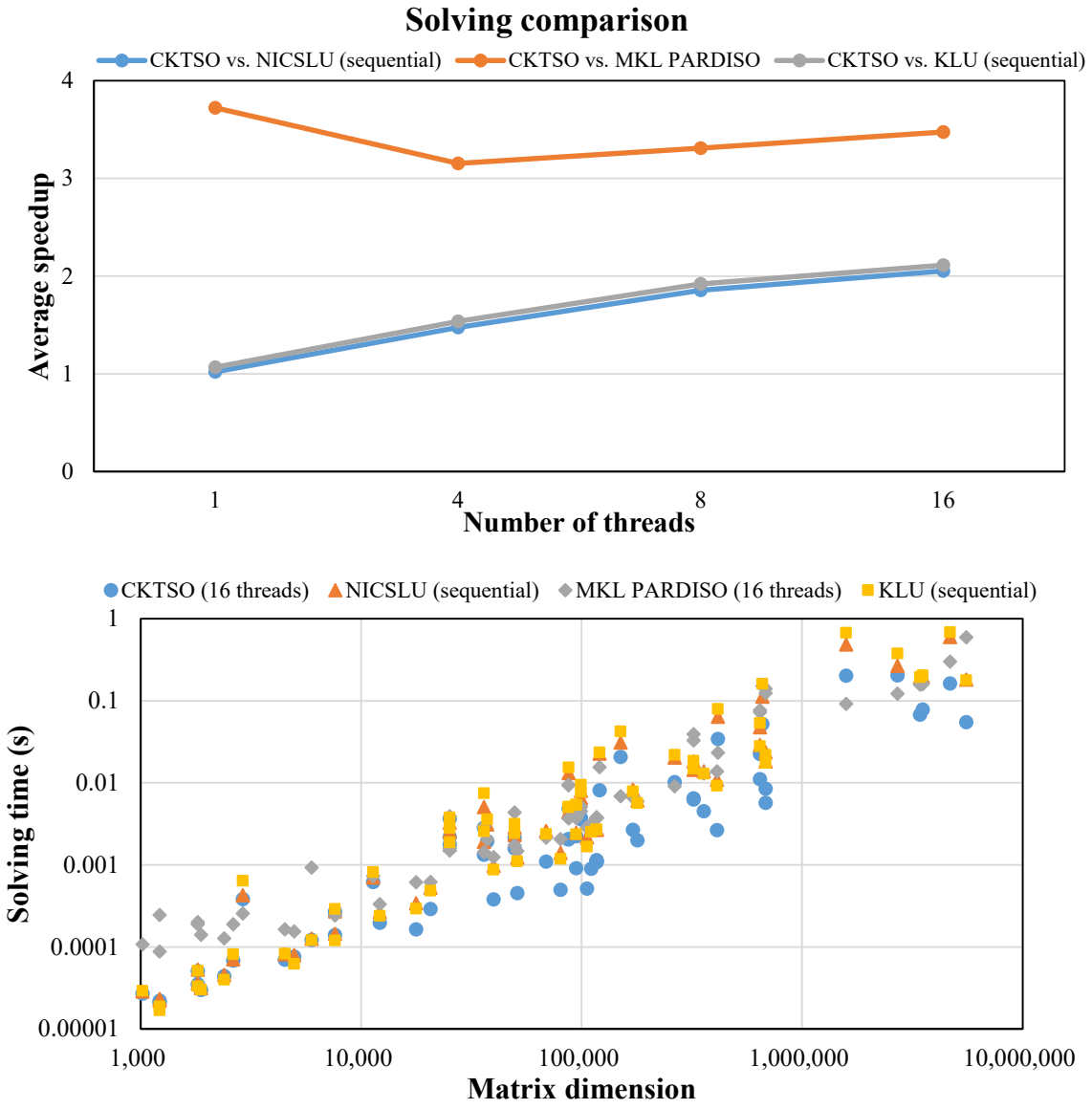


2. Re-factorization Performance





3. Solving Performance

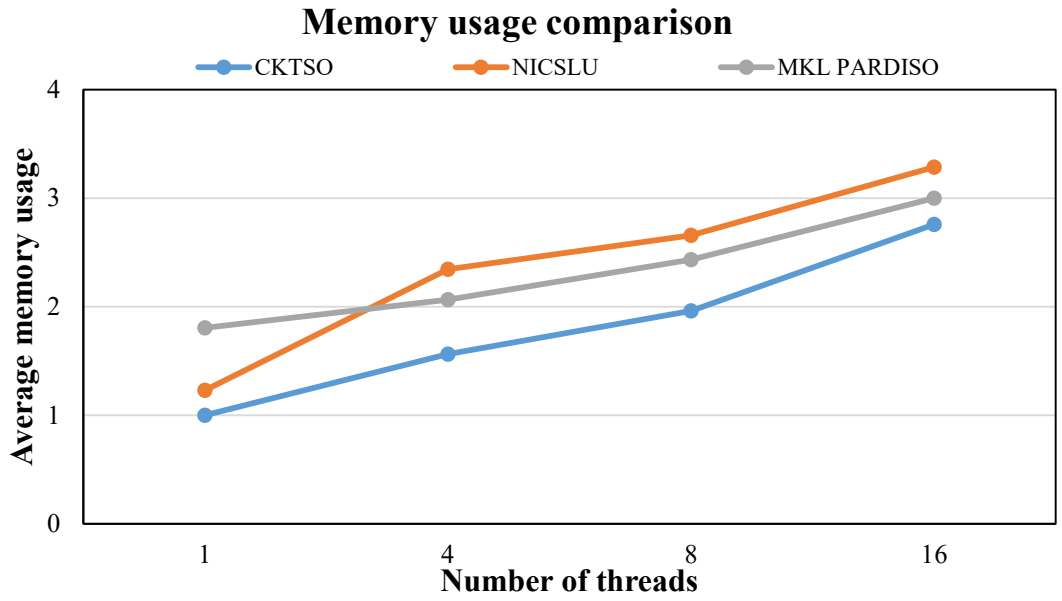


4. Solution Accuracy

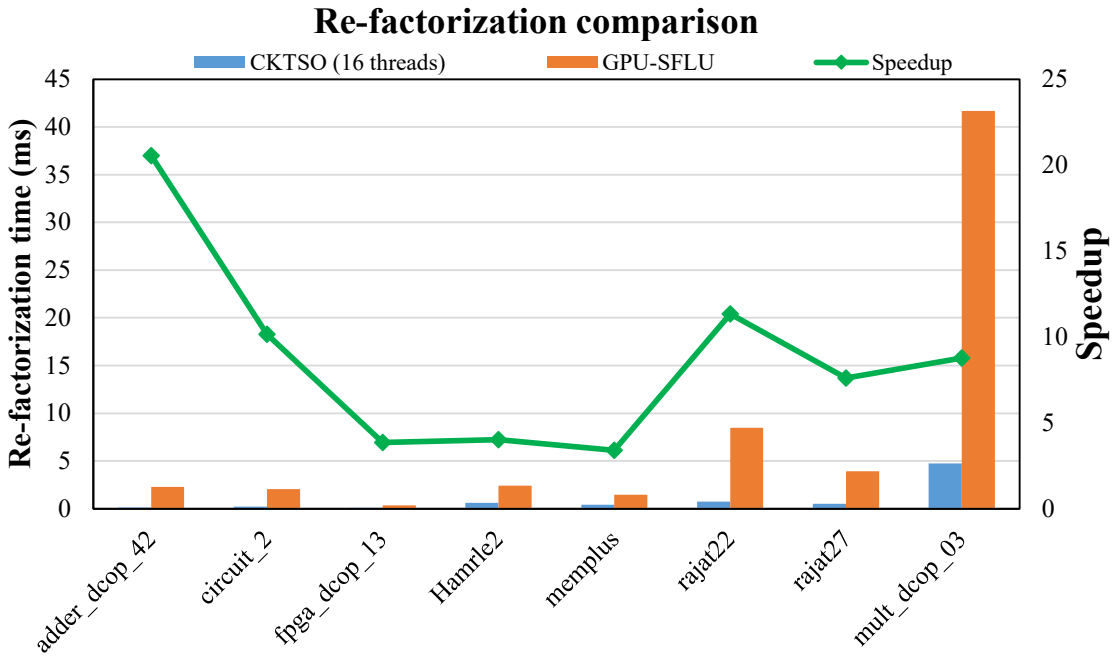
The L2-norm of the residual, i.e. $\|\boldsymbol{Ax} - \boldsymbol{b}\|_2$, is evaluated. CKTSO generates slightly small error than KLU and similar error to NICSLU. Compared with MKL PARDISO, CKTSO reduces error by 3.56X on geometric mean.

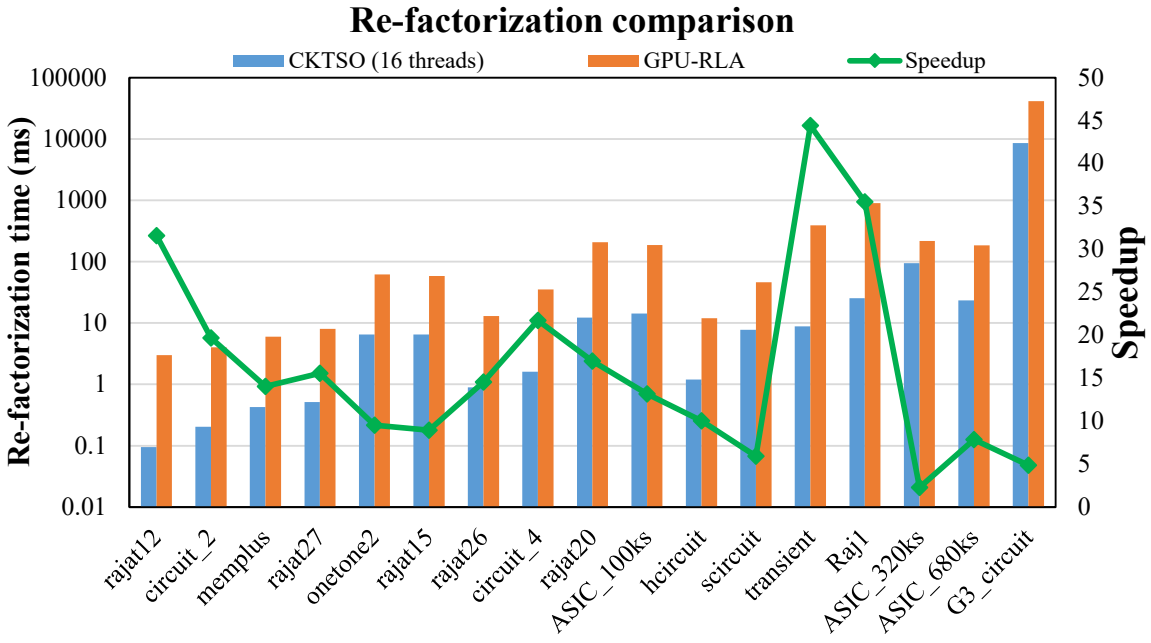
5. Memory Usage

Memory usage numbers are normalized to sequential CKTSO.



6. Re-factorization Performance Comparisons with GPU-based Solvers




Re-factorization comparison
CKTSO (16 threads)
GPU-RLA
Speedup
Re-factorization time (ms)
Speedup
100000
10000
1000
100
10
1
0.1
0.01
50
45
40
35
30
25
20
15
10
5
0
rajat12
circuit_2
memplus
rajat27
onetone2
rajat15
rajat26
circuit_4
rajat20
ASIC_100ks
hcircuit
scircuit
transient
Raj1
ASIC_320ks
ASIC_680ks
G3_circuit