SUPERLU - FULL SET OF RESULTS

How is the error computed:

Relative forward error:

$$RFE = \frac{\|x - x_{\text{exact}}\|_{\infty}}{\|x\|_{\infty}}$$

Normwise relative backward error:

NBRE =
$$\frac{||Ax - b||_{\infty}}{||A||x| + |b|||_{\infty}}$$

Name	Rows	Columns	NNZ un	NNZ L+U	NNZ inc	av. RFE	av. NBRE	Failure rate
TAMU 500	56010	56010	410882	1288292.56	3.14x	$5.63 \cdot 10^{-4}$	$9.76 \cdot 10^{-7}$	0 %
Case 118	214492	214492	2343288	8612421.75	3.68x	$2.59 \cdot 10^{-10}$	$1.17 \cdot 10^{-15}$	0 %
RTS - 1 TP	2237	2237	11297	55810.35	4.94x	$4.34 \cdot 10^{-6}$	$1.81 \cdot 10^{-16}$	5 %
RTS - 2 TP	4766	4766	23762	125639.97	5.29x	$9.00 \cdot 10^{-6}$	$2.02 \cdot 10^{-16}$	5%
ACTIVSg200	4644	4644	21630	133847.2	6.19x	$3.69 \cdot 10^{-7}$	$1.78 \cdot 10^{-5}$	0 %
ACTIVSg2000	55667	55667	268299	1911570.3	7.12x	$5.38 \cdot 10^{-7}$	$2.73 \cdot 10^{-15}$	0 %
ACTIVSg10k	238072	238072	1111990.8	7252607.2	6.52x	$2,74 \cdot 10^{-8}$	$5.78 \cdot 10^{-6}$	0 %
ACTIVSg70k	1640411	1640411	7671693	52579080	6.85x	0.0072	1.045	0 %

Table 1: The error levels achieved by SuperLU_dist; NNZL+U – combined nonzeros in the L and U factors (measure of the fill-in level); NNZ inc.- increase in non zeros inside L and U; Failure rate – ratio of the matrices for which SuperLU failed to the total number of matrices in a test case.

The computations performed by SuperLU can be divided into 8 phases:

- 1. Equilibration (scaling),
- 2. Row permutation,
- 3. Column permutation,
- 4. Symbolic factorization,
- 5. Data distribution (through MPI),
- 6. (Full) factorization,
- 7. Solve,
- 8. Iterative refinement.

			TAMU 5	500 (CPU, com	ect RH	S)			
Ranks	Equil	Row perm	Col perm	Sym factor	Dist	Factor	Solve	Ref	TOTAL
1	0.00	0.05	0.26	0.01	0.10	0.28	0.01	0.03	1.45
6	0.00	0.05	0.27	0.01	0.10	0.26	0.02	0.03	1.42
21	0.00	0.05	0.27	0.01	0.05	0.20	0.02	0.04	1.48
42	0.01	0.05	0.27	0.01	0.09	0.26	0.02	0.05	1.49
				8 (CPU, corre					
Ranks	Equil	Row perm	Col perm	Sym factor	Dist	Factor	Solve	Ref	TOTAL
1	0.02	0.17	1.20	0.09	0.55	1.67	0.06	0.24	7.82
6	0.01	0.17	1.24	0.10	0.30	3.67	0.12	0.35	9.76
21	0.01	0.17	1.26	0.10	0.29	2.65	0.10	0.28	8.61
42	0.01	0.18	1.26	0.10	0.42	1.91	0.08	0.23	7.93
		R	ΓS - One Tin	ne Period (CPI	J, corre	ct RHS)			
Ranks	Equil	Row perm	Col perm	Sym factor	Dist	Factor	Solve	Ref	TOTAL
1	0.00	0.00	0.01	0.00	0.01	0.05	0.00	0.01	0.13
6	0.00	0.01	0.01	0.00	0.00	0.04	0.01	0.02	0.11
21	0.00	0.01	0.01	0.00	0.00	0.03	0.00	0.01	0.10
42	0.00	0.01	0.01	0.00	0.01	0.03	0.00	0.02	0.12
72	0.00	0.01	0.01	0.00	0.01	0.03	0.00	0.02	0.12
		D	DG	D : L/CDI	т.	· DIIO)			
D 1	Б 11			ne Period (CPI			0.1	D.C	тоты
Ranks	Equil	Row perm	Col perm	Sym factor	Dist	Factor	Solve	Ref	TOTAL
1	0.00	0.01	0.02	0.00	0.01	0.08	0.00	0.01	0.23
6	0.00	0.01	0.03	0.00	0.01	0.07	0.01	0.03	0.21
21	0.00	0.01	0.03	0.00	0.01	0.05	0.01	0.02	0.18
42	0.00	0.01	0.03	0.00	0.01	0.05	0.01	0.03	0.20
			ACTIV	VSg200 (correc	et RHS)				
Ranks	Equil	Row perm	Col perm	Sym factor	Dist	Factor	Solve	Ref	TOTAL
1	0.00	0.00	0.02	0.00	0.01	0.03	0.00	0.00	0.13
6	0.00	0.00	0.02	0.00	0.00	0.06	0.01	0.01	0.18
21	0.00	0.00	0.02	0.00	0.01	0.04	0.01	0.01	0.15
42	0.00	0.00	0.02	0.00	0.01	0.05	0.01	0.01	0.17
			ACTIVS	2000 (CPU, co	orrect R	HS)			
Ranks	Equil	Row perm	Col perm	Sym factor	Dist	Factor	Solve	Ref	TOTAL
1	0.00	0.04	0.41	0.02	0.12	0.42	0.01	0.04	1.85
6	0.00	0.04	0.42	0.02	0.06	0.52	0.03	0.06	1.82
21	0.00	0.04	0.42	0.02	0.06	0.54	0.04	0.08	1.86
42	0.02	0.04	0.42	0.02	0.10	0.40	0.03	0.06	1.77
72	0.02	0.04	0.42	0.02	0.10	0.40	0.03	0.00	1.//
			A CIDITAL	101 (CDI)		10)			
ъ.				g10k (CPU, co				ъ.	mom: r
Ranks	Equil	Row perm	Col perm	Sym factor	Dist	Factor	Solve	Ref	TOTAL
1	0.01	0.17	1.92	0.08	0.47	1.41	0.05	0.30	7.22
6	0.01	0.17	1.96	0.08	0.25	2.29	0.09	0.45	8.05
21	0.01	0.17	1.98	0.08	0.25	1.41	0.07	0.34	6.99
42	0.01	0.17	1.98	0.08	0.37	1.02	0.06	0.24	6.71
			ACTIVS	g70k (CPU, co	rrect RI	HS)			
Ranks	Equil	Row perm	Col perm	Sym factor	Dist	Factor	Solve	Ref	TOTAL
1	0.09	1.04	15.69	0.55	3.51	10.89	0.37	1.12	51.66
6	0.05	1.04	16.34	0.56	1.68	17.22	0.60	1.05	57.21
21	0.05	1.06	16.75	0.56	1.67	12.09	0.40	0.52	51.60
42	0.08	1.07	16.76	0.57	2.67	7.71	0.31	0.67	49.13
	5.50	1.07	10.70	0.57		, 1	0.01		.,.10

Table 2: SuperLU results computed on the CPU (without GPU acceleration) with correct right-hand sides. Times are reported in seconds.

			TAMILS	500 (CPU, defa	ult PH	2)			
Ranks	Equil	Dow parm	Col perm	Sym factor	Dist	Factor	Solve	Ref	TOTAL
	Equil	Row perm		•					
1	0.00	0.05	0.27	0.01	0.12	0.29	0.01	0.03	1.43
6	0.00	0.05	0.27	0.01	0.06	0.24	0.02	0.04	1.37
21	0.00	0.05	0.27	0.01	0.06	0.32	0.02	0.05	1.45
42	0.00	0.05	0.27	0.01	0.09	0.26	0.02	0.05	1.44
			Case 11	8 (CPU, defai	ult RHS)			
Ranks	Equil	Row perm	Col perm	Sym factor	Dist	Factor	Solve	Ref	TOTAL
1	0.02	0.17	1.20	0.09	0.59	1.68	0.06	0.25	7.57
6		0.17	1.25	0.09		3.76	0.00	0.23	9.70
	0.01				0.34				
21	0.01	0.17	1.26	0.10	0.31	3.40	0.10	0.32	9.26
42	0.01	0.18	1.26	0.10	0.43	1.91	0.08	0.23	7.75
		R	ΓS - One Tin	ne Period (CPU	J, defau	lt RHS)			
Ranks	Equil	Row perm	Col perm	Sym factor	Dist	Factor	Solve	Ref	TOTAL
1	0.00	0.00	0.01	0.00	0.01	0.05	0.00	0.01	0.13
6	0.00	0.01	0.01	0.00	0.00	0.04	0.01	0.02	0.11
21	0.00	0.01	0.01	0.00	0.00	0.03	0.01	0.02	0.11
42	0.00	0.01	0.01	0.00	0.00	0.03	0.01	0.02	0.11
42	0.00	0.01	0.01	0.00	0.01	0.03	0.01	0.02	0.11
				_	_				
				ne Period (CPU		lt RHS)			
Ranks	Equil	Row perm	Col perm	Sym factor	Dist	Factor	Solve	Ref	TOTAL
1	0.00	0.01	0.02	0.00	0.01	0.08	0.00	0.01	0.22
6	0.00	0.01	0.03	0.00	0.01	0.07	0.01	0.03	0.21
21	0.00	0.01	0.03	0.00	0.01	0.05	0.01	0.02	0.18
42	0.00	0.01	0.03	0.00	0.01	0.05	0.01	0.03	0.19
									0.22
			ACTIV	70, 200 (1.6.	l DIIO				
D 1	г 1	D		/Sg200 (defau		Г ,	0.1	D.C	тоты
Ranks	Equil	Row perm	Col perm	Sym factor	Dist	Factor	Solve	Ref	TOTAL
1	0.00	0.00	0.02	0.00	0.01	0.03	0.00	0.01	0.18
6	() ()()		0.02	0.00	0.00	0.05	0.01	0.07	0.22
	0.00	0.00							
21	0.00	0.00	0.02	0.00	0.01	0.04	0.01	0.05	0.18
21 42				0.00 0.00	0.01 0.01	0.04 0.04	0.01 0.01		0.18 0.19
	0.00	0.00	0.02					0.05	
	0.00	0.00	0.02 0.02	0.00	0.01	0.04		0.05	
42	0.00	0.00	0.02 0.02 ACTIVSg	0.00 2000 (CPU, de	0.01 efault RI	0.04 HS)	0.01	0.05 0.04	0.19
42 Ranks	0.00 0.00 Equil	0.00 0.00 Row perm	0.02 0.02 ACTIVSg: Col perm	0.00 2000 (CPU, de Sym factor	0.01 efault Rl Dist	0.04 HS) Factor	0.01 Solve	0.05 0.04 Ref	0.19
Ranks	0.00 0.00 Equil 0.00	0.00 0.00 Row perm 0.04	0.02 0.02 ACTIVSg Col perm 0.41	0.00 2000 (CPU, de Sym factor 0.02	0.01 efault RI Dist 0.12	0.04 HS) Factor 0.42	0.01 Solve 0.01	0.05 0.04 Ref 0.08	0.19 TOTAL 1.82
Ranks 1 6	0.00 0.00 Equil 0.00 0.00	0.00 0.00 Row perm 0.04 0.04	0.02 0.02 ACTIVSg Col perm 0.41 0.42	0.00 2000 (CPU, de Sym factor 0.02 0.02	0.01 efault Rl Dist 0.12 0.06	0.04 HS) Factor 0.42 0.65	0.01 Solve 0.01 0.04	0.05 0.04 Ref 0.08 0.17	0.19 TOTAL 1.82 2.01
Ranks 1 6 21	0.00 0.00 Equil 0.00 0.00 0.00	0.00 0.00 Row perm 0.04 0.04 0.04	0.02 0.02 ACTIVSg Col perm 0.41 0.42 0.42	0.00 2000 (CPU, de Sym factor 0.02 0.02 0.02	0.01 efault RI Dist 0.12 0.06 0.06	0.04 HS) Factor 0.42 0.65 0.57	0.01 Solve 0.01 0.04 0.03	0.05 0.04 Ref 0.08 0.17 0.18	0.19 TOTAL 1.82 2.01 1.93
Ranks 1 6	0.00 0.00 Equil 0.00 0.00	0.00 0.00 Row perm 0.04 0.04	0.02 0.02 ACTIVSg Col perm 0.41 0.42	0.00 2000 (CPU, de Sym factor 0.02 0.02	0.01 efault Rl Dist 0.12 0.06	0.04 HS) Factor 0.42 0.65	0.01 Solve 0.01 0.04	0.05 0.04 Ref 0.08 0.17	0.19 TOTAL 1.82 2.01
Ranks 1 6 21	0.00 0.00 Equil 0.00 0.00 0.00	0.00 0.00 Row perm 0.04 0.04 0.04	0.02 0.02 ACTIVSg: Col perm 0.41 0.42 0.42	0.00 2000 (CPU, de Sym factor 0.02 0.02 0.02 0.02	0.01 Pfault RI Dist 0.12 0.06 0.06 0.09	0.04 HS) Factor 0.42 0.65 0.57 0.40	0.01 Solve 0.01 0.04 0.03	0.05 0.04 Ref 0.08 0.17 0.18	0.19 TOTAL 1.82 2.01 1.93
Ranks 1 6 21	0.00 0.00 Equil 0.00 0.00 0.00	0.00 0.00 Row perm 0.04 0.04 0.04	0.02 0.02 ACTIVSg: Col perm 0.41 0.42 0.42	0.00 2000 (CPU, de Sym factor 0.02 0.02 0.02	0.01 Pfault RI Dist 0.12 0.06 0.06 0.09	0.04 HS) Factor 0.42 0.65 0.57 0.40	0.01 Solve 0.01 0.04 0.03	0.05 0.04 Ref 0.08 0.17 0.18	0.19 TOTAL 1.82 2.01 1.93
Ranks 1 6 21	0.00 0.00 Equil 0.00 0.00 0.00	0.00 0.00 Row perm 0.04 0.04 0.04	0.02 0.02 ACTIVSg: Col perm 0.41 0.42 0.42	0.00 2000 (CPU, de Sym factor 0.02 0.02 0.02 0.02	0.01 Pfault RI Dist 0.12 0.06 0.06 0.09	0.04 HS) Factor 0.42 0.65 0.57 0.40	0.01 Solve 0.01 0.04 0.03	0.05 0.04 Ref 0.08 0.17 0.18	0.19 TOTAL 1.82 2.01 1.93
Ranks 1 6 21 42	0.00 0.00 Equil 0.00 0.00 0.00 0.00	0.00 0.00 Row perm 0.04 0.04 0.04	0.02 0.02 ACTIVSg Col perm 0.41 0.42 0.42 0.42	0.00 2000 (CPU, de Sym factor 0.02 0.02 0.02 0.02 10k (CPU, det	0.01 Dist 0.12 0.06 0.06 0.09 fault RF Dist	0.04 HS) Factor 0.42 0.65 0.57 0.40	0.01 Solve 0.01 0.04 0.03 0.03	0.05 0.04 Ref 0.08 0.17 0.18 0.14	0.19 TOTAL 1.82 2.01 1.93 1.77
Ranks 1 6 21 42 Ranks 1	0.00 0.00 Equil 0.00 0.00 0.00 0.00	0.00 0.00 Row perm 0.04 0.04 0.04 0.04 0.04	0.02 0.02 0.02 ACTIVSg Col perm 0.41 0.42 0.42 0.42 Col perm 1.91	0.00 2000 (CPU, de Sym factor 0.02 0.02 0.02 0.02 0.02 sym factor 0.08	0.01 Dist 0.12 0.06 0.06 0.09 fault RF Dist 0.47	0.04 HS) Factor 0.42 0.65 0.57 0.40 HS) Factor 1.40	0.01 Solve 0.01 0.04 0.03 0.03 Solve 0.05	0.05 0.04 Ref 0.08 0.17 0.18 0.14	0.19 TOTAL 1.82 2.01 1.93 1.77 TOTAL 7.06
Ranks 1 6 21 42 Ranks 1 6 6	0.00 0.00 0.00 0.00 0.00 0.00 0.00 Equil 0.01 0.01	0.00 0.00 Row perm 0.04 0.04 0.04 0.04 Row perm 0.17 0.17	0.02 0.02 0.02 ACTIVSg Col perm 0.41 0.42 0.42 0.42 Col perm 1.91 1.96	0.00 2000 (CPU, de Sym factor 0.02 0.02 0.02 0.02 0.02 0.02 0.02 Sym factor 0.08 0.08	0.01 Dist 0.12 0.06 0.06 0.09 fault RF Dist 0.47 0.25	0.04 HS) Factor 0.42 0.65 0.57 0.40 HS) Factor 1.40 2.16	0.01 Solve 0.01 0.04 0.03 0.03 Solve 0.05 0.09	0.05 0.04 Ref 0.08 0.17 0.18 0.14	0.19 TOTAL 1.82 2.01 1.93 1.77 TOTAL 7.06 7.86
Ranks 1 6 21 42 Ranks 1 6 21 21	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	0.00 0.00 Row perm 0.04 0.04 0.04 0.04 0.17	0.02 0.02 0.02 ACTIVSg Col perm 0.41 0.42 0.42 0.42 Col perm 1.91 1.96 1.98	0.00 2000 (CPU, de Sym factor 0.02 0.02 0.02 0.02 10k (CPU, det Sym factor 0.08 0.08 0.08 0.08	0.01 Dist 0.12 0.06 0.06 0.09 fault RF Dist 0.47 0.25 0.25	0.04 HS) Factor 0.42 0.65 0.57 0.40 HS) Factor 1.40 2.16 1.45	Solve 0.01 0.04 0.03 0.03 Solve 0.05 0.09 0.07	0.05 0.04 Ref 0.08 0.17 0.18 0.14 Ref 0.43 0.60 0.41	0.19 TOTAL 1.82 2.01 1.93 1.77 TOTAL 7.06 7.86 6.92
Ranks 1 6 21 42 Ranks 1 6 6	0.00 0.00 0.00 0.00 0.00 0.00 0.00 Equil 0.01 0.01	0.00 0.00 Row perm 0.04 0.04 0.04 0.04 Row perm 0.17 0.17	0.02 0.02 0.02 ACTIVSg Col perm 0.41 0.42 0.42 0.42 Col perm 1.91 1.96	0.00 2000 (CPU, de Sym factor 0.02 0.02 0.02 0.02 0.02 0.02 0.02 Sym factor 0.08 0.08	0.01 Dist 0.12 0.06 0.06 0.09 fault RF Dist 0.47 0.25	0.04 HS) Factor 0.42 0.65 0.57 0.40 HS) Factor 1.40 2.16	0.01 Solve 0.01 0.04 0.03 0.03 Solve 0.05 0.09	0.05 0.04 Ref 0.08 0.17 0.18 0.14	0.19 TOTAL 1.82 2.01 1.93 1.77 TOTAL 7.06 7.86
Ranks 1 6 21 42 Ranks 1 6 21 21	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	0.00 0.00 Row perm 0.04 0.04 0.04 0.04 0.17	0.02 0.02 0.02 ACTIVSg Col perm 0.41 0.42 0.42 0.42 Col perm 1.91 1.96 1.98 1.98	0.00 2000 (CPU, de Sym factor 0.02 0.02 0.02 0.02 10k (CPU, de Sym factor 0.08 0.08 0.08 0.08 0.08	0.01 Dist 0.12 0.06 0.06 0.09 fault RF Dist 0.47 0.25 0.25 0.37	0.04 HS) Factor 0.42 0.65 0.57 0.40 HS) Factor 1.40 2.16 1.45 1.02	Solve 0.01 0.04 0.03 0.03 Solve 0.05 0.09 0.07	0.05 0.04 Ref 0.08 0.17 0.18 0.14 Ref 0.43 0.60 0.41	0.19 TOTAL 1.82 2.01 1.93 1.77 TOTAL 7.06 7.86 6.92
Ranks 1 6 21 42 Ranks 1 6 21 42	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	0.00 0.00 Row perm 0.04 0.04 0.04 0.04 0.17 0.17 0.17	0.02 0.02 0.02 Col perm 0.41 0.42 0.42 0.42 Tellow 1.91 1.96 1.98 1.98	0.00 2000 (CPU, de Sym factor 0.02 0.02 0.02 0.02 10k (CPU, de Sym factor 0.08 0.08 0.08 0.08	0.01 Dist 0.12 0.06 0.06 0.09 fault RF Dist 0.47 0.25 0.25 0.37	0.04 HS) Factor 0.42 0.65 0.57 0.40 HS) Factor 1.40 2.16 1.45 1.02	Solve 0.01 0.04 0.03 0.03 0.03 Solve 0.05 0.09 0.07 0.05	0.05 0.04 Ref 0.08 0.17 0.18 0.14 Ref 0.43 0.60 0.41 0.33	0.19 TOTAL 1.82 2.01 1.93 1.77 TOTAL 7.06 7.86 6.92 6.48
Ranks 1 6 21 42 Ranks 1 6 21 42 Ranks	0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01	0.00 0.00 0.00 Row perm 0.04 0.04 0.04 0.17 0.17 0.17 0.17	0.02 0.02 0.02 Col perm 0.41 0.42 0.42 0.42 TACTIVSg Col perm 1.91 1.96 1.98 1.98 Col perm	0.00 2000 (CPU, de Sym factor 0.02 0.02 0.02 0.02 310k (CPU, de Sym factor 0.08 0.08 0.08 0.08 370k (CPU, de Sym factor 0.08 0.08 0.08	0.01 Dist 0.12 0.06 0.06 0.09 fault RF Dist 0.47 0.25 0.25 0.37 fault RF Dist	0.04 HS) Factor 0.42 0.65 0.57 0.40 HS) Factor 1.40 2.16 1.45 1.02 HS) Factor	Solve 0.01 0.04 0.03 0.03 Solve 0.05 0.09 0.07 0.05	0.05 0.04 Ref 0.08 0.17 0.18 0.14 Ref 0.43 0.60 0.41 0.33	0.19 TOTAL 1.82 2.01 1.93 1.77 TOTAL 7.06 7.86 6.92 6.48 TOTAL
Ranks 1 6 21 42 Ranks 1 6 21 42 Ranks 1 Ranks 1	0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01	0.00 0.00 Row perm 0.04 0.04 0.04 0.04 0.17 0.17 0.17 0.17 0.17 1.04	0.02 0.02 0.02 Col perm 0.41 0.42 0.42 0.42 0.42 ACTIVSg Col perm 1.91 1.96 1.98 1.98 Col perm 15.68	0.00 2000 (CPU, de Sym factor 0.02 0.02 0.02 0.02 310k (CPU, de Sym factor 0.08 0.08 0.08 0.08 370k (CPU, de Sym factor 0.55	0.01 Dist 0.12 0.06 0.06 0.09 fault RF Dist 0.47 0.25 0.37 fault RF Dist 3.54	0.04 HS) Factor 0.42 0.65 0.57 0.40 HS) Factor 1.40 2.16 1.45 1.02 HS) Factor 10.93	Solve 0.01 0.04 0.03 0.03 Solve 0.05 0.09 0.07 0.05 Solve 0.36	0.05 0.04 Ref 0.08 0.17 0.18 0.14 Ref 0.43 0.60 0.41 0.33	0.19 TOTAL 1.82 2.01 1.93 1.77 TOTAL 7.06 7.86 6.92 6.48
Ranks 1 6 21 42 Ranks 1 6 21 42 Ranks	0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01	0.00 0.00 0.00 Row perm 0.04 0.04 0.04 0.17 0.17 0.17 0.17	0.02 0.02 0.02 Col perm 0.41 0.42 0.42 0.42 TACTIVSg Col perm 1.91 1.96 1.98 1.98 Col perm	0.00 2000 (CPU, de Sym factor 0.02 0.02 0.02 0.02 310k (CPU, de Sym factor 0.08 0.08 0.08 0.08 370k (CPU, de Sym factor 0.08 0.08 0.08	0.01 Dist 0.12 0.06 0.06 0.09 fault RF Dist 0.47 0.25 0.25 0.37 fault RF Dist	0.04 HS) Factor 0.42 0.65 0.57 0.40 HS) Factor 1.40 2.16 1.45 1.02 HS) Factor	Solve 0.01 0.04 0.03 0.03 Solve 0.05 0.09 0.07 0.05	0.05 0.04 Ref 0.08 0.17 0.18 0.14 Ref 0.43 0.60 0.41 0.33	0.19 TOTAL 1.82 2.01 1.93 1.77 TOTAL 7.06 7.86 6.92 6.48 TOTAL
Ranks 1 6 21 42 Ranks 1 6 21 42 Ranks 1 Ranks 1	0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01	0.00 0.00 Row perm 0.04 0.04 0.04 0.04 0.17 0.17 0.17 0.17 0.17 1.04	0.02 0.02 0.02 Col perm 0.41 0.42 0.42 0.42 0.42 ACTIVSg Col perm 1.91 1.96 1.98 1.98 Col perm 15.68	0.00 2000 (CPU, de Sym factor 0.02 0.02 0.02 0.02 310k (CPU, de Sym factor 0.08 0.08 0.08 0.08 370k (CPU, de Sym factor 0.55	0.01 Dist 0.12 0.06 0.06 0.09 fault RF Dist 0.47 0.25 0.37 fault RF Dist 3.54	0.04 HS) Factor 0.42 0.65 0.57 0.40 HS) Factor 1.40 2.16 1.45 1.02 HS) Factor 10.93	Solve 0.01 0.04 0.03 0.03 Solve 0.05 0.09 0.07 0.05 Solve 0.36	0.05 0.04 Ref 0.08 0.17 0.18 0.14 Ref 0.43 0.60 0.41 0.33	0.19 TOTAL 1.82 2.01 1.93 1.77 TOTAL 7.06 7.86 6.92 6.48 TOTAL 50.35
Ranks 1 6 21 42 Ranks 1 6 21 42 Ranks 1 6 6 1 6	0.00 0.00 0.00 0.00 0.00 0.00 0.01 0.01	0.00 0.00 0.00 Row perm 0.04 0.04 0.04 0.07 0.17 0.17 0.17 0.17 0.17 0.17	0.02 0.02 0.02 Col perm 0.41 0.42 0.42 0.42 0.42 ACTIVSg Col perm 1.91 1.96 1.98 1.98 Col perm 15.68 16.36	0.00 2000 (CPU, de Sym factor 0.02 0.02 0.02 0.02 310k (CPU, de Sym factor 0.08 0.08 0.08 0.08 370k (CPU, de Sym factor 0.55 0.56	0.01 Dist 0.12 0.06 0.06 0.09 Fault RF Dist 0.47 0.25 0.25 0.37 Fault RF Dist 3.54 1.73	0.04 HS) Factor 0.42 0.65 0.57 0.40 HS) Factor 1.40 2.16 1.45 1.02 HS) Factor 10.93 17.26	Solve 0.01 0.04 0.03 0.03 Solve 0.05 0.09 0.07 0.05 Solve 0.36 0.59	0.05 0.04 Ref 0.08 0.17 0.18 0.14 Ref 0.43 0.60 0.41 0.33	0.19 TOTAL 1.82 2.01 1.93 1.77 TOTAL 7.06 7.86 6.92 6.48 TOTAL 50.35 56.81

Table 3: SuperLU results computed on the CPU (without GPU acceleration) with default right-hand sides. Times are reported in seconds.

			TAMII 5	00 (CDI) 20m	oot DU	(C)			
Ranks	Equil	Dow norm		00 (GPU, corr Sym factor	Dist	Factor	Solve	Ref	TOTAL
1	Equil 0.00	Row perm 0.05	Col perm 0.26	0.01	0.11	0.78	0.01	0.03	2.14
2	0.00	0.05	0.20	0.01	0.11	1.47	0.01	0.03	2.14
6	0.00	0.05	0.27	0.01	0.06	2.13	0.02	0.04	3.30
			Casa 11	8 (GPU, corre	ct DUS	2)			
Ranks	Equil	Row perm	Col perm	Sym factor	Dist	Factor	Solve	Ref	TOTAL
1	0.02	0.17	1.20	0.09	0.54	2.23	0.06	0.23	8.33
2	0.02	0.17	1.24	0.09	0.48	2.23	0.00	0.23	9.31
6	0.02	0.17	1.24	0.10	0.31	5.74	0.12	0.40	11.88
U	0.01	0.17	1.27	0.10	0.51	3.74	0.13	0.40	11.00
		RT	S - One Tim	e Period (GPU	J. corre	ect RHS)			
Ranks	Equil	Row perm	Col perm	Sym factor	Dist	Factor	Solve	Ref	TOTAL
1	0.00	0.00	0.01	0.00	0.01	0.53	0.00	0.00	0.59
2	0.00	0.00	0.01	0.00	0.00	0.77	0.01	0.02	0.84
6	0.00	0.01	0.01	0.00	0.00	1.93	0.01	0.02	2.00
Ü	0.00	0.01	0.01	0.00	0.00	1,70	0.01	0.02	2.00
		RTS	S - Two Tim	e Period (GP	U, corre	ect RHS)			
Ranks	Equil	Row perm	Col perm	Sym factor	Dist	Factor	Solve	Ref	TOTAL
1	0.00	0.01	0.02	0.00	0.01	0.58	0.00	0.01	0.71
2	0.00	0.01	0.03	0.00	0.01	0.78	0.01	0.02	0.91
6	0.00	0.01	0.03	0.00	0.01	1.95	0.01	0.03	2.09
				200 (GPU, co		•			1
Ranks	Equil	Row perm	Col perm	Sym factor	Dist	Factor	Solve	Ref	TOTAL
1				$\alpha \alpha \alpha$	Ω Ω 1	0.52	0.00	0.00	0.62
1	0.00	0.00	0.02	0.00	0.01			0.00	0.62
2	0.00	0.00	0.02	0.00	0.01	0.77	0.00	0.00	0.87
2	0.00	0.00	0.02 0.02	0.00 0.00	0.01 0.00	0.77 1.91	0.00	0.00	0.87
2 6	0.00	0.00 0.00	0.02 0.02 ACTTIVS2	0.00 0.00 2000 (GPU, co	0.01 0.00 orrect R	0.77 1.91 (HS)	0.00 0.01	0.00 0.01	0.87 2.03
2 6 Ranks	0.00 0.00	0.00 0.00 Row perm	0.02 0.02 ACTTIVS2 Col perm	0.00 0.00 2000 (GPU, co Sym factor	0.01 0.00 orrect R	0.77 1.91 AHS) Factor	0.00 0.01 Solve	0.00 0.01	0.87 2.03
2 6 Ranks	0.00 0.00 Equil 0.00	0.00 0.00 Row perm 0.04	0.02 0.02 ACTTIVS2 Col perm 0.41	0.00 0.00 2000 (GPU, co Sym factor 0.02	0.01 0.00 orrect R Dist 0.13	0.77 1.91 AHS) Factor 0.91	0.00 0.01 Solve 0.01	0.00 0.01 Ref 0.04	0.87 2.03 TOTAL 2.38
2 6 Ranks 1 2	0.00 0.00 Equil 0.00 0.00	0.00 0.00 Row perm 0.04 0.04	0.02 0.02 ACTTIVS2 Col perm 0.41 0.42	0.00 0.00 2000 (GPU, co Sym factor 0.02 0.02	0.01 0.00 brrect R Dist 0.13 0.12	0.77 1.91 2HS) Factor 0.91 1.22	0.00 0.01 Solve 0.01 0.03	0.00 0.01 Ref 0.04 0.07	0.87 2.03 TOTAL 2.38 2.59
2 6 Ranks	0.00 0.00 Equil 0.00	0.00 0.00 Row perm 0.04	0.02 0.02 ACTTIVS2 Col perm 0.41	0.00 0.00 2000 (GPU, co Sym factor 0.02	0.01 0.00 orrect R Dist 0.13	0.77 1.91 AHS) Factor 0.91	0.00 0.01 Solve 0.01	0.00 0.01 Ref 0.04	0.87 2.03 TOTAL 2.38
2 6 Ranks 1 2	0.00 0.00 Equil 0.00 0.00	0.00 0.00 Row perm 0.04 0.04	0.02 0.02 ACTTIVS2 Col perm 0.41 0.42 0.42	0.00 0.00 2000 (GPU, co Sym factor 0.02 0.02 0.02	0.01 0.00 Direct R Dist 0.13 0.12 0.07	0.77 1.91 EHS) Factor 0.91 1.22 2.41	0.00 0.01 Solve 0.01 0.03	0.00 0.01 Ref 0.04 0.07	0.87 2.03 TOTAL 2.38 2.59
2 6 Ranks 1 2 6	0.00 0.00 Equil 0.00 0.00 0.00	0.00 0.00 Row perm 0.04 0.04 0.04	0.02 0.02 ACTTIVS2 Col perm 0.41 0.42 0.42 ACTTIVS	0.00 0.00 2000 (GPU, co Sym factor 0.02 0.02 0.02	0.01 0.00 orrect R Dist 0.13 0.12 0.07	0.77 1.91 2HS) Factor 0.91 1.22 2.41	0.00 0.01 Solve 0.01 0.03 0.04	0.00 0.01 Ref 0.04 0.07 0.07	0.87 2.03 TOTAL 2.38 2.59 3.73
2 6 Ranks 1 2 6	0.00 0.00 Equil 0.00 0.00 0.00	0.00 0.00 Row perm 0.04 0.04 0.04	0.02 0.02 ACTTIVS2 Col perm 0.41 0.42 0.42 ACTTIVS Col perm	0.00 0.00 2000 (GPU, co Sym factor 0.02 0.02 0.02 10k (GPU, co Sym factor	0.01 0.00 orrect R Dist 0.13 0.12 0.07	0.77 1.91 EHS) Factor 0.91 1.22 2.41 HS) Factor	0.00 0.01 Solve 0.01 0.03 0.04	0.00 0.01 Ref 0.04 0.07 0.07	0.87 2.03 TOTAL 2.38 2.59 3.73
2 6 Ranks 1 2 6	0.00 0.00 Equil 0.00 0.00 0.00	0.00 0.00 Row perm 0.04 0.04 0.04 Row perm 0.16	0.02 0.02 ACTTIVS2 Col perm 0.41 0.42 0.42 ACTTIVS Col perm 1.91	0.00 0.00 2000 (GPU, co Sym factor 0.02 0.02 0.02 10k (GPU, co Sym factor 0.08	0.01 0.00 orrect R Dist 0.13 0.12 0.07 rrect R Dist 0.48	0.77 1.91 HS) Factor 0.91 1.22 2.41 HS) Factor 1.84	0.00 0.01 Solve 0.01 0.03 0.04	0.00 0.01 Ref 0.04 0.07 0.07	0.87 2.03 TOTAL 2.38 2.59 3.73 TOTAL 7.51
2 6 Ranks 1 2 6	0.00 0.00 Equil 0.00 0.00 0.00	0.00 0.00 Row perm 0.04 0.04 0.04 Row perm 0.16 0.16	0.02 0.02 ACTTIVS2 Col perm 0.41 0.42 0.42 ACTTIVS Col perm 1.91 1.96	0.00 0.00 2000 (GPU, co Sym factor 0.02 0.02 0.02 10k (GPU, co Sym factor 0.08 0.08	0.01 0.00 orrect R Dist 0.13 0.12 0.07 rrect R Dist 0.48 0.43	0.77 1.91 EHS) Factor 0.91 1.22 2.41 HS) Factor 1.84 2.55	0.00 0.01 Solve 0.01 0.03 0.04 Solve 0.05 0.11	0.00 0.01 Ref 0.04 0.07 0.07	0.87 2.03 TOTAL 2.38 2.59 3.73 TOTAL 7.51 8.66
2 6 Ranks 1 2 6	0.00 0.00 Equil 0.00 0.00 0.00	0.00 0.00 Row perm 0.04 0.04 0.04 Row perm 0.16	0.02 0.02 ACTTIVS2 Col perm 0.41 0.42 0.42 ACTTIVS Col perm 1.91	0.00 0.00 2000 (GPU, co Sym factor 0.02 0.02 0.02 10k (GPU, co Sym factor 0.08	0.01 0.00 orrect R Dist 0.13 0.12 0.07 rrect R Dist 0.48	0.77 1.91 HS) Factor 0.91 1.22 2.41 HS) Factor 1.84	0.00 0.01 Solve 0.01 0.03 0.04	0.00 0.01 Ref 0.04 0.07 0.07	0.87 2.03 TOTAL 2.38 2.59 3.73 TOTAL 7.51
2 6 Ranks 1 2 6	0.00 0.00 Equil 0.00 0.00 0.00	0.00 0.00 Row perm 0.04 0.04 0.04 Row perm 0.16 0.16	0.02 0.02 ACTTIVS2 Col perm 0.41 0.42 0.42 ACTTIVS Col perm 1.91 1.96 1.96	0.00 0.00 2000 (GPU, co Sym factor 0.02 0.02 0.02 10k (GPU, co Sym factor 0.08 0.08	0.01 0.00 orrect R Dist 0.13 0.12 0.07 Dist 0.48 0.43 0.27	0.77 1.91 EHS) Factor 0.91 1.22 2.41 HS) Factor 1.84 2.55 3.96	0.00 0.01 Solve 0.01 0.03 0.04 Solve 0.05 0.11	0.00 0.01 Ref 0.04 0.07 0.07	0.87 2.03 TOTAL 2.38 2.59 3.73 TOTAL 7.51 8.66
2 6 Ranks 1 2 6	0.00 0.00 Equil 0.00 0.00 0.00	0.00 0.00 Row perm 0.04 0.04 0.04 Row perm 0.16 0.16	0.02 0.02 ACTTIVS2 Col perm 0.41 0.42 0.42 ACTTIVS Col perm 1.91 1.96 1.96	0.00 0.00 2000 (GPU, co Sym factor 0.02 0.02 0.02 0.02 10k (GPU, co Sym factor 0.08 0.08 0.08	0.01 0.00 orrect R Dist 0.13 0.12 0.07 Dist 0.48 0.43 0.27	0.77 1.91 EHS) Factor 0.91 1.22 2.41 HS) Factor 1.84 2.55 3.96	0.00 0.01 Solve 0.01 0.03 0.04 Solve 0.05 0.11	0.00 0.01 Ref 0.04 0.07 0.07	0.87 2.03 TOTAL 2.38 2.59 3.73 TOTAL 7.51 8.66
2 6 Ranks 1 2 6 Ranks 1 2 6	0.00 0.00 Equil 0.00 0.00 0.00 Equil 0.01 0.01	0.00 0.00 Row perm 0.04 0.04 0.04 Row perm 0.16 0.16 0.16	0.02 0.02 ACTTIVS2 Col perm 0.41 0.42 0.42 ACTTIVS Col perm 1.91 1.96 1.96	0.00 0.00 2000 (GPU, co Sym factor 0.02 0.02 0.02 0.02 10k (GPU, co Sym factor 0.08 0.08 0.08	0.01 0.00 Dist 0.13 0.12 0.07 rrect R Dist 0.48 0.43 0.27	0.77 1.91 (HS) Factor 0.91 1.22 2.41 (HS) Factor 1.84 2.55 3.96	0.00 0.01 Solve 0.01 0.03 0.04 Solve 0.05 0.11	0.00 0.01 Ref 0.04 0.07 0.07 Ref 0.33 0.61 0.53	0.87 2.03 TOTAL 2.38 2.59 3.73 TOTAL 7.51 8.66 9.78
Ranks 1 2 6 Ranks 1 2 6	0.00 0.00 0.00 0.00 0.00 0.00 Equil 0.01 0.01	0.00 0.00 Row perm 0.04 0.04 0.04 Row perm 0.16 0.16 0.16	0.02 0.02 ACTTIVS2 Col perm 0.41 0.42 0.42 ACTTIVS Col perm 1.91 1.96 1.96 ACTTIVS	0.00 0.00 2000 (GPU, co Sym factor 0.02 0.02 0.02 10k (GPU, co Sym factor 0.08 0.08 0.08	0.01 0.00 orrect R Dist 0.13 0.12 0.07 rrect R Dist 0.48 0.43 0.27	0.77 1.91 EHS) Factor 0.91 1.22 2.41 EHS) Factor 1.84 2.55 3.96 EHS)	0.00 0.01 Solve 0.01 0.03 0.04 Solve 0.05 0.11 0.10	0.00 0.01 Ref 0.04 0.07 0.07 Ref 0.33 0.61 0.53	0.87 2.03 TOTAL 2.38 2.59 3.73 TOTAL 7.51 8.66 9.78

Table 4: SuperLU results computed on the GPU with correct right-hand sides. Each rank is using a separate GPU. Times are reported in seconds.