

CUSOLVER – FULL SET OF RESULTS

How is the error computed:

Relative residual:

$$\text{RR} = \frac{\|b - Ax\|}{\|b\|}$$

Normwise Backward Residual Error (NBRE v2)

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

| Name | av. RR | av. NRBE | Failure rate |
|--------------------|-----------------------|-----------------------|--------------|
| TAMU 500 | | | |
| LU | $1.83 \cdot 10^{-9}$ | $1.52 \cdot 10^{-23}$ | 0 % |
| QR | $1.77 \cdot 10^{-9}$ | $1.49 \cdot 10^{-23}$ | 0 % |
| Case 118 | | | |
| LU | $3.47 \cdot 10^{-14}$ | $2.17 \cdot 10^{-17}$ | 0 % |
| QR | – | – | 100 % |
| RTS – 1 TP | | | |
| LU | $1.22 \cdot 10^{-4}$ | $9.93 \cdot 10^{-13}$ | 5% |
| QR | $1.22 \cdot 10^{-4}$ | $9.94 \cdot 10^{-13}$ | 5% |
| RTS – 2 TP | | | |
| LU | $1.59 \cdot 10^{-4}$ | $2.68 \cdot 10^{-12}$ | 4% |
| QR | $1.59 \cdot 10^{-4}$ | $2.68 \cdot 10^{-12}$ | 4% |
| ACTIVSg200 | | | |
| LU | $1.68 \cdot 10^{-9}$ | $1.99 \cdot 10^{-16}$ | 0% |
| QR | $1.68 \cdot 10^{-9}$ | $2.99 \cdot 10^{-16}$ | 0% |
| ACTIVSg2000 | | | |
| LU | $9.07 \cdot 10^{-17}$ | $6.10 \cdot 10^{-23}$ | 0% |
| QR | $2.96 \cdot 10^{-16}$ | $3.30 \cdot 10^{-22}$ | 0% |
| ACTIVSg10k | | | |
| LU | $1.41 \cdot 10^{-10}$ | $1.30 \cdot 10^{-21}$ | 0% |
| QR | $3.47 \cdot 10^{-11}$ | $3.24 \cdot 10^{-22}$ | 0% |
| ACTIVSg70k | | | |
| LU | $9.98 \cdot 10^{-7}$ | $4.53 \cdot 10^{-21}$ | 0 % |
| QR | – | – | 100 % |

Table 1: The error levels achieved in cuSolver. Metis reordering was used for all the test cases.

All results presented in this document have been computed on one node of Oak Ridge OLCF summit supercomputer. Note: at a first glance, it seems that the error levels are the same for QR and LU on the figures, however, subtle small differences exist. The data have been thoroughly checked to ensure we are not using duplicates.

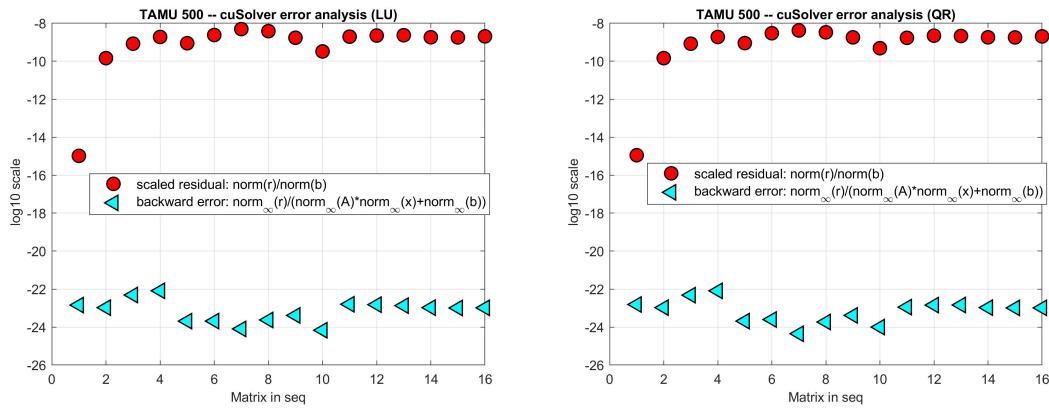


Figure 1: Error levers for TAMU 500

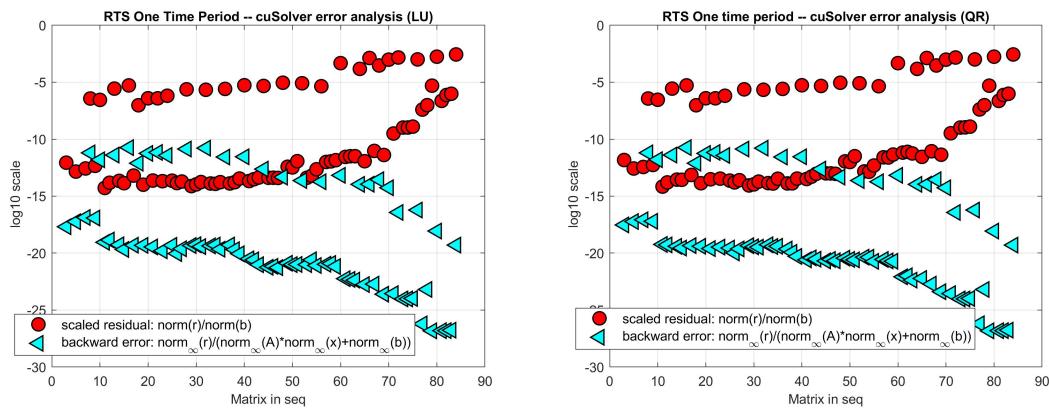


Figure 2: Error levers for RTS One Time Period

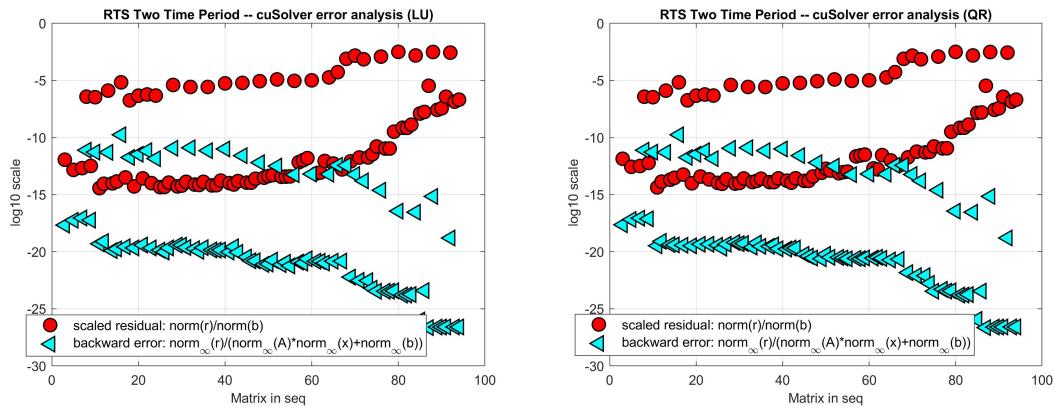


Figure 3: Error levers for RTS Two Time Period

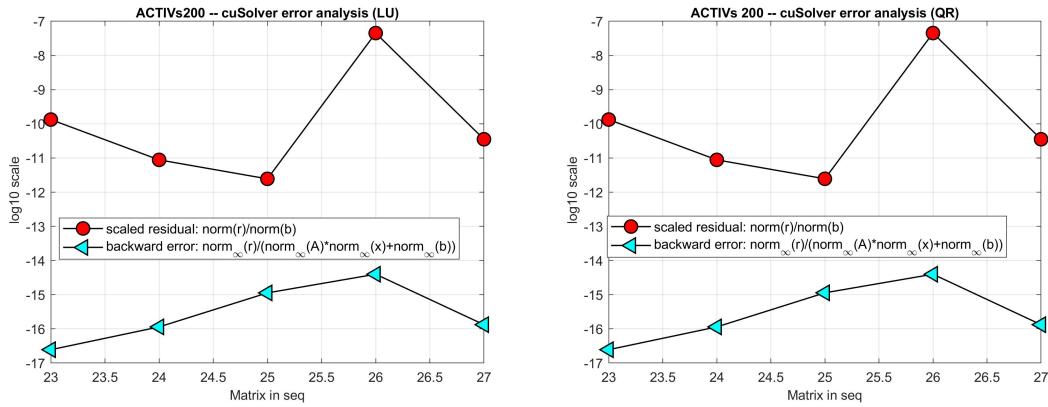


Figure 4: Error levers for ACTIVSg200

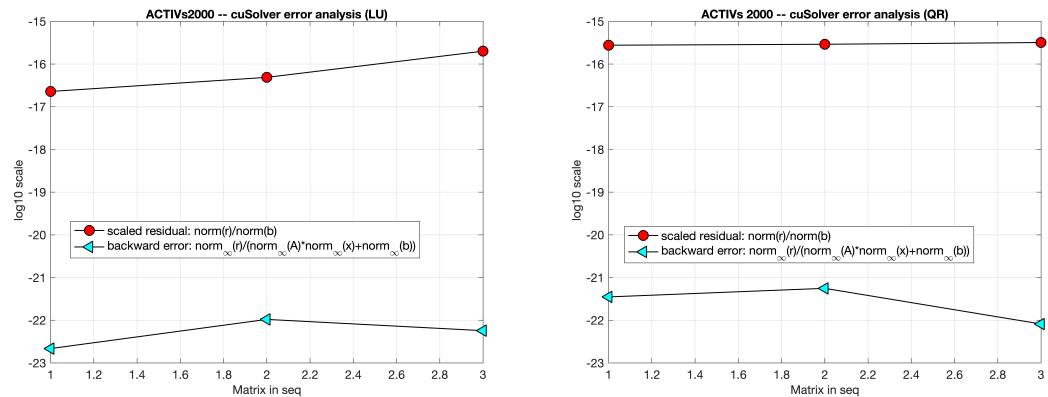


Figure 5: Error levers for ACTIVSg2000

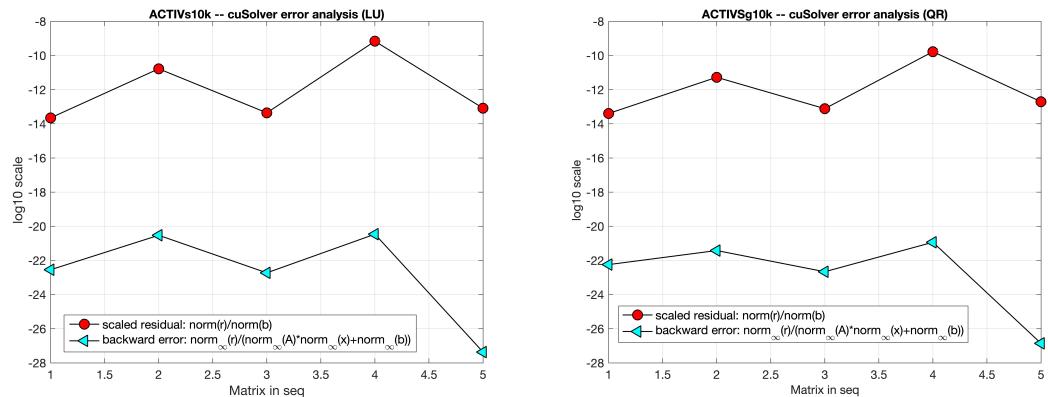


Figure 6: Error levers for ACTIVSg10k

| RTS - 1 TP | | | RTS - 2 TP | |
|------------|-----------------|-----------------|-----------------|-----------------|
| Reordering | Average time LU | Average time QR | Average time LU | Average time QR |
| none | 740.82 ms | 203.03 ms | 7150.24 ms | 1309.61 ms |
| 1 | 6.52 ms | 16.18 ms | 43.18 ms | 86.45 ms |
| 2 | 16.26 ms | 37.45 ms | 91.12 ms | 133.31 ms |
| 3 | 19.55 ms | 43.88 ms | 65.00 ms | 131.76 ms |

| TAMU 500 | | | |
|------------|-------------------------|----------------------|--|
| Reordering | Average time LU | Average time QR | |
| none | ≈ 1762715.23 ms | ≈ 7088.85 ms | |
| 1 | 18369.79 ms | 4233.98 ms | |
| 2 | 4678.50 ms | 7308.98 ms | |
| 3 | 1695.81 ms | 4265.44 ms | |

| ACTIVSg200 | | | ACTIVSg2000 | | ACTIVSg10k | |
|------------|-------------|-------------|-----------------|-------------|--------------|-------------|
| Reordering | Av. time LU | Av. time QR | Average time LU | Av. time QR | Av. time LU | Av. time QR |
| none | 3066.97 ms | 1289.74 ms | — | 83919.5 ms | — | — |
| 1 | 17.17 ms | 36.75 ms | 8826.67 ms | 1792.54 ms | 31898.50 ms | 5726.92 ms |
| 2 | 44.58 ms | 92.95 ms | 8802.65 ms | 6451.32 ms | 100377.00 ms | 73907.70 ms |
| 3 | 44.01 ms | 108.62 ms | 2641.67 ms | 4300.18 ms | 18191.00 ms | 17335.20 ms |

Table 2: Performance results for cuSolver with different re-ordering options. Note that the ratio between the timings resulting from best and worst reordering in some cases is larger than a 1000.

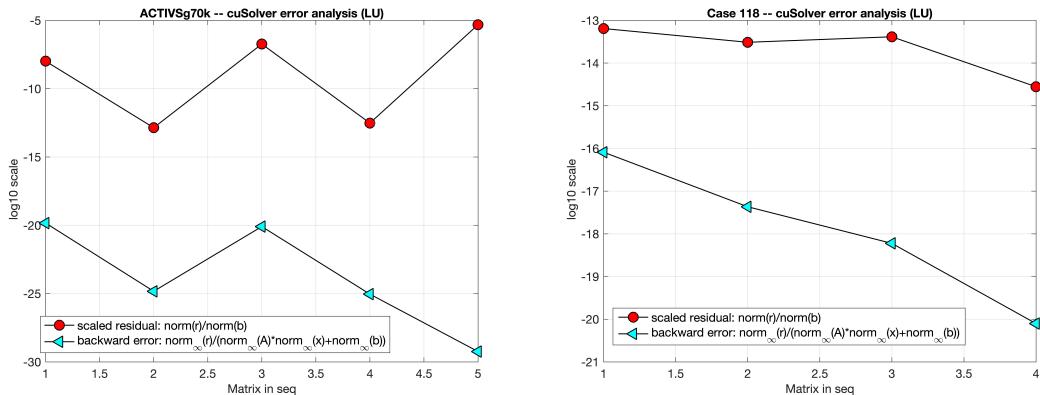


Figure 7: Error levers for ACTIVSg70k and Case 118. For both test cases, QR solver fails.