Entropy Maximization in Sparse Matrix by Vector Multiplication ($\max_E SpMV$)

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- The peak performance of any SpMV depends primarily on the available memory bandwidth and the capability to use it effectively.
- 3 GPUs, ASICs, and new FPGAs have higher and higher bandwidth; however, for large scale and highly sparse matrices we find still
- 4 difficult utilizing this bandwidth because the SpMV random access pattern and workload imbalance. We propose a matrix permutation
- 5 pre-processing step that aims to maximize the entropy of the distribution of the nonzero elements. We seek any permutation that
- uniformly distributes the non-zero elements' distribution, thereby generating a SpMV problem that is amenable to work load balancing
- or to speed up sort algorithms. We conjecture these permutations would be most effective for matrices with no dense rows or columns
- and, as in preconditioning, when the matrix is reused. We shall show that entropy maximization is an optimization that any architecture
- 9 may take advantage although in different ways. Most importantly, any developer can consider and deploy. We shall present cases
- where we can improve performance by 15% on AMD-based systems.

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1 INTRODUCTION

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To define the scope of this work, the obvious questions to ask are: first, what randomization or entropy maximization is in the context of sparse matrices; second, why would we use it; third, when it does work. We shall provide formal definitions in the following sections. Briefly, we will permute randomly the rows and columns of a sparse matrix before multiplying it with a dense vector (SpMV) with the aim of speeding this operation. Undoubtedly, this scheme requires some restrictions about the matrix structure, one among them is that is has no or few dense columns or rows. In the case, where there are dense columns or rows, a sparse/dense partitioning scheme should be used. For the remainder of this manuscript, we shall assume the former nonzero structure. We use randomization because it is the poor man's way for preconditioning SpMV in our context, and we do not mean it in a pejorative sense.

Preconditioning speeds up the convergence rate of an iterative linear solver by linearly transforming the associated matrix into a form that affords a faster reduction of the residual error at every iteration. The cost of this transformation is justified by the runtime reduction it affords. Likewise, we foresee randomization playing a similar role for SpMV in the context of iterative linear solvers and other methods (e.g in convolutions) where the matrix is reused.

Sparse linear algebra and GraphBLAS kernels are memory bound and there is a common thread in the scientific computing community to develop acceleration libraries mostly for multi-core systems. These predominantly include multi-core processors and GPUs. The goal is a balanced work distribution and, when applicable, minimal communication

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[6, 11]. When storage strategy and algorithms must be considered together then GPUs provide the work horse for abundant thrust in research [1]. These works aim at optimal solutions and strive for a clear and complete understanding/exploitation of the software-hardware interface; usually the hardware is composed of symmetric computational units. Interestingly, the SpMV's space and time complexity, which are small, may not warrant more performance because we typically end up utilizing only one-thousandth fraction of the available hardware capacity.

The peak performance of any SpMV accelerator depends primarily on the available memory bandwidth (i.e., DRAM such as DDR or HBM) and the capability of the accelerator to effectively use it. Because SpMV is memory-bound, a more important metric than peak performance alone is the fraction of bandwidth utilized, which captures the overall efficiency of the architecture. GPU platforms exhibit very high bandwidth, see the experimental Section 8: Ellesmere DDR5 224GB/s, Fiji HBM 512GB/s, and Vega 20 HBM 1TB/s. Although utilizing this much bandwidth efficiently is difficult for large scale and highly sparse matrices due to very high random access pattern. Custom architectures based on FPGA or ASIC devices can maximize bandwidth utilization by highly customized data-paths and memory hierarchy designs [3, 4, 13]. Most of the existing accelerators saturate the relatively low memory bandwidth available on FPGA platforms (less than 80 GB/s) [3, 4, 8, 10, 12, 13]. Modern FPGA platforms have multiple HBM stacks to provide large memory bandwidth. However, there is no implementation (currently available) that saturates all of the available DRAM bandwidth for SpMV kernel on HBM-enabled FPGA platforms. Scalability of accelerator design remains a major concern, and it is an active area of research.

FPGA platforms used in early works exhibit low peak performance due to the scarcity of external memory bandwidth [3, 7, 14]. For example, Microsoft's implementation of SpMV uses an FPGA platform which only has 2 DDR2-400 memory banks with a resulting bandwidth of 6.4 GB/s [7]. The accelerator is running at 100 MHz, it reads 64 Bytes of data every cycle, which corresponds to 5 non-zeros at every cycle (a non-zero is about 12 Bytes). At best, the peak performance is 10 double precision operations every cycle at 100 MHz, which is 1 GFLOPS (only). In 2009, Convey systems Inc. released the Convey HC-1 FPGA platform. It has 16 DDR2-677 memories resulting in overall 80 GB/s memory bandwidth [10]. The accelerator logic runs at 150 MHz. It consumes 512 Bytes of data every cycle, which corresponds to around 40 non-zeros every cycle. At best, the peak performance is 80 double precision operations every cycle at 150 MHz, which is 12 GFLOPS.

One of the key building blocks for custom architecture solutions is a multi-ported buffer used to storing vector entries [3]. During execution, multiple column indices are used as addresses to read corresponding vector entries; we shall provide more details about the application in Section 2. Designing a buffer with a very large number of read ports is challenging. One solution is banking as a mechanism to store partitioned vector entries. Although banking could allow very high throughput indexing unless the same entry is required multiple times and its reads are purely sequential causing loss of bandwidth. For example, hashing techniques and data duplication are possible solutions for this problem. However, another issue arises: When we distribute SpMV computations across p-nodes, some of the nodes, say k, finish later than the rest because of unbalanced work loads (i.e., number of nonzero element) in row/column major traversal. This is a common phenomena for matrices where few rows or columns are dense. These k nodes are referred to as laggard nodes. By applying random permutation of columns/rows, we are attempting to balance the loads across all p workers so that there are no laggards. From this hardware vantage point, randomization or maximizing the entropy of the non-zero element distribution is an optimization transform and provides a clear context for our work.

Clearly, optimally accelerating SpMV is a hard many-parameters optimization problem dependent on the choice of algorithm, data structures, and dedicated hardware (CPU, GPUs, FPGA's, Custom ASIC's). Rather, our goal is to provide a tool, we may say a naive tool, to help understand how the structure of the matrix may affect the HW-SW Manuscript submitted to ACM

solution. For the readers in the field of algorithms, SpMV can be mapped into a sorting algorithm. For example, finding elements $x_{i,j}$ and $x_{i,k>j}$ in a sparse matrix requires to find row i and then columns j and k. Sorting is a method to find if an element is in a list with no prior or limited knowledge of its contents. Sorting can be used to prepare the matrix and to find elements in between sparse matrices and sparse vectors. In custom architectures, sorting networks are used to route matrix and vector elements to functional units. In a sense, if one is stuck with a sorting algorithm and a poor distribution, randomization may alter the distribution and throttle performance. Interestingly, the best sorting algorithm is a function of the distribution of the elements [5, 9].

We organize this work as follows: In Section 2, we define the matrix by vector operation; in Section 3, we define what we mean by randomization or entropy maximization. We use randomization to create a uniform distribution in Section 5 and measure uniformity by entropy in Section 4. We present how we drive our experiments to show the effects of randomization in Section 6. In the last sections, we present a summary of the results: we present our work loads for the given benchmarks in Section 7, and the complete set of measures for an AMD CPU and GPUs systems in Section 8.

2 BASIC NOTATIONS

Let us start by describing the basic notations so we can clear the obvious (or not). A Sparse-matrix by vector multiplication SpMV on an (semi) ring based on the operations (+,*) is defined as $\mathbf{y} = \mathbb{M}\mathbf{x}$ so that $y_i = \sum_j M_{i,j} * y_j$ where $M_{i,j} = 0$ are not represented nor stored. Most of the experimental results in Section 8 are based on the classic addition (+) and multiplication (*) in floating point precision using 64 bits (i.e., double floating point precision) albeit are extensible to other semi-rings. For instance, it is well known that SpMV defined on the semi-ring (min,+) is a kernel in computing an all-pairs shortest paths starting with a graph adjacency matrix, and in using a Boolean algebra we can check if two nodes are connected, which is slightly simpler.

We identify a sparse matrix \mathbb{M} of size $M \times N$ as having O(M+N) non-zero elements, number of non zero nnz. Thus the complexity of $\mathbb{M}x$ is $O(M+N) \approx 2nnz$. Also, we must read at least nnz elements and thus the complexity is $\Theta(M+N) \approx nnz$. We can appreciate that reading the data is as complex as the overall operation. Of course, the definition of sparsity may vary. We represent the matrix \mathbb{M} by using the coordinate list COO or and the compressed sparse row CSR^1 formats. The COO represents the non-zero of a matrix by a triplet (i, j, v); very often there are three identical-in-size vectors for the ROW, COLUMN, and VALUE. The COO format takes $3 \times nnz$ space and two consecutive elements in the value array are not bound to be neither in the same row nor column. In fact, we know only that $VALUE[i] = M_{ROW[i],COLUMN[i]}$.

The CSR format stores elements in the same row and with increasing column values consecutively. There are three arrays V, COL, and ROW. The ROW is sorted in increasing order. Its size is M, and ROW[i] is an index in V and COL describing where i-th row starts (i.e., if row i exists). Accordingly, $M_{i,*}$ is stored in V[ROW[i]: ROW[i+1]]. The column indices are stored at COL[ROW[i]: ROW[i+1]] and sorted increasingly. The CSR format takes $2 \times nnz + M$ space and a row vector of the matrix can be found in O(1).

The computation $y_i = \sum_j M_{i,j} * x_j$ is a sequence of scalar products and, using the CSR format, is computed as follows:

$$Index = ROW[i] : ROW[i+1]$$
$$y_i = \sum_{\ell \in Index} V[\ell] * x_{COL[\ell]}$$

¹a.k.a. Compressed row storage CRS.

The matrix row is contiguous (in memory) and rows are stored in increasing order. However, the access of the dense vector \mathbf{x} has no particular pattern, well increasing.

The COO format can be endowed with certain properties. For example, we can sort the array by row and add row information to achieve the same properties of CSR. In contrast, transposing a "sorted" COO matrix simply entails swapping of the arrays ROW and COL. Think about matrix multiply (one of us does constantly). Each scalar product achieves peak performance if the reads of the vector \mathbf{x} are streamlined as much as possible and so the reads of the vector V. If we have multiple cores, each could compute a subset of the y_i and a clean data load balancing can go a long way. If we have few functional units, we would like to have a constant stream of independent * and * operations but with data already in registers. That is, data pre-fetch will go a long way especially for $x_{COL[i]}$, which may have an irregular pattern.

3 RANDOMIZATION AND ENTROPY MAXIMIZATION

We define Randomization as row or column permutation transform of the matrix \mathbb{M} (thus a permutation of \mathbf{y} and \mathbf{x}), and we choose these by a pseudo-random process. The obvious question to as is why should we seek randomization transform? The sparsity of a given matrix \mathbb{M} has a non-zero element distribution induced by the nature of the original problem or by some imposed ordering on the respective nodes of its associated graph. This distribution may be computationally incompatible with the chosen algorithm or architecture. For instance, it can induce some load imbalance in the computation. We could break this load imbalance by seeking to maximize entropy for this distribution. Our conjecture is that would favor the average case performance rather than the worse case when operating on the "max-entropy transformed" matrix.

For linear system solvers, if we know the matrix \mathbb{M} , and we know the architecture, preconditioning (when affordable) is a better solution. If we run experiments long enough, we choose the best permutation(s) for the architecture, permute \mathbb{M} , and go on testing the next. On one end, preconditioning exerts a full understanding of both the matrix (the problem) and how the final solution will be computed (architecture). On the other end, the simplicity of a random permutation requires no information about the matrix, the vector, and the architecture. Such a simplicity can be exploited directly in Hardware. We are after an understanding when randomization is just enough: We seek to let the hardware do its best with the least effort, or at least with the appearance to be effortless.

Interestingly, this work stems from a sincere surprise about randomization efficacy and its application on custom SpMV. Here, we wish to study this problem systematically so that to help future hardware designs. Intuitively, if we can achieve a uniform distribution of the rows of matrix \mathbb{M} we can have provable expectation of its load balancing across multiple cores. If we have a uniform distribution of accesses on \mathbf{x} we could exploit column load balancing and exploit better sorting algorithms: In practice, the reading of $\mathbf{x}_{COL[i]}$ can be reduced to a sorting, and there we know that different sparsity may require different algorithms. This may be a lot to unpack but it translates to a better performance of the sequential algorithm without changing the algorithm or to improved bandwidth utilization.

We will show that (different) randomness affects architectures and algorithms differently, making randomization a suitable optimization transform especially when the application and hardware are at odds: Hardware (unless programmable) is difficult to change and the matrix sparsity is simple to change. We want to show that there is a randomness hierarchy that we can distinguish as global and local. There are simple-to-find cases where the sparsity breaks randomness optimization. For instance, matrices with dense rows or columns are better partitioned into sparse and dense components and operated on separately.

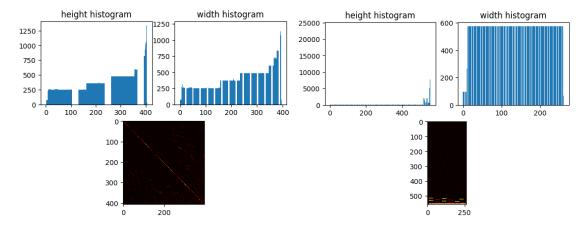


Fig. 1. Left: OPF 3754. Right: LP OSA 07. These are histograms where we represent normalized buckets and counts

4 ENTROPY

Patterns in sparse matrices are often visually pleasing, see Figure 1 where we present the height histogram, the width histograms, and a two-dimensional histogram as heat map. We will let someone else using AI picture classification. Intuitively, we would like to express a measure of uniform distribution and here we apply the basics: *Entropy*. Given an histogram $i \in [0, M-1]$ $h_i \in \mathbb{N}$, we define $S = \sum_{i=0}^{M-1} h_i$ and thus we have a probability distribution function $p_i = \frac{h_i}{S}$. The *information* of bin i is defined as $I(i) = -\log_2 p_i$. If we say that the stochastic variable X has PDF p_i than the entropy of X is defined as.

$$H(x) = -\sum_{i=0}^{M-1} p_i \log_2 p_i = \sum_{i=0}^{M-1} p_i I(i) = E[I_X]$$
 (1)

The maximum entropy is when $\forall i, p_i = p = \frac{1}{M}$; that is, we are observing a uniform distributed event. Our randomization should aim at higher entropy numbers. The entropy for matrix LP OSA 07 is 8.41 and for OPF 3754 is 8.39. We use the entropy specified in the Scipy stats module. A single number is concise and satisfying. If you are pondering why they are so close contrary to their sparsity we discuss this next.

5 UNIFORM DISTRIBUTION

We know that we should **not** compare the entropy numbers of two matrices because entropy does not use any information about the order of the buckets, it uses only their probabilities. By construction, the matrices are quite different in sparsity and in shapes, however their entropy numbers are close. Two matrices with the same number of non-zeros, spaced well enough in the proper number of bin, will have the same entropy. To appreciate their different sparsity, we should compare their entropy distributions by Jensen-Shannon measure [2] or we could use cumulative distribution function (CDF) measures, which imply an order. Here, we use a representation of a hierarchical 2D-entropy, see Figure 2, where the entropy is split into 2x2, 4x4 and 8x8 (or fewer if the distribution is not square). We have hierarchical entropy heat maps.

We can see that even a small 2D-entropy matrix summarizes the nature of the original matrix because it has spatial information. In this work, the entropy matrix is used mostly for visualization purpose more than for comparison purpose.

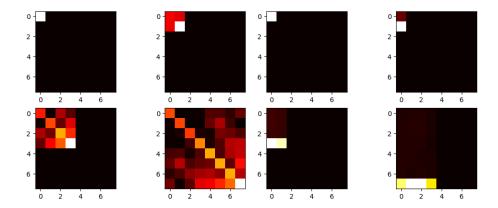


Fig. 2. Hierarchical 2D entropy for OPF 3754 (left) and LP OSA 07 (right).

Of course, we can appreciate how the matrix LP OSA 07 has a few very heavy rows and they are clustered. This matrix will help us showing how randomization need some tips. Now we apply row and column random permutation once by row and one by column: Figure 3: OPF has now entropy 11.27 and LP 9.26. The numerical difference is significant. The good news is that for entropy, being an expectation, we can use simple techniques like bootstrap to show that the difference is significant or we have shown that Jensen-Shannon can be used and a significance level is available. What we like to see is the the hierarchical entropy heat map is becoming *more* uniform for at least one of the matrix.

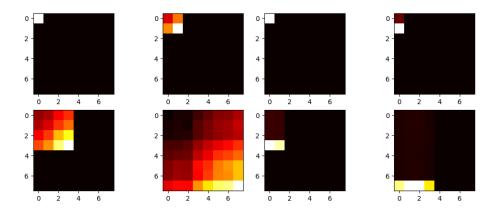


Fig. 3. Hierarchical 2D entropy after row and column random permutation for OPF 3754 (left) and LP OSA 07 (right).

In practice, permutations need some help especially for relatively large matrices. As you can see, the permutation affects locally the matrix. Of course, it depends on the implementation of the random permutation, we use *numpy* for this. It is reasonable that a slightly modified version of the original is still a random selection and unfortunately they seem too likely in practice. We need to compensate or help the randomization. If we are able to identify the row and column that divide high and low density, we could use them as pivot for a shuffle like in a quick-sort algorithm. We could apply a sorting algorithm but its complexity will the same of SpMV. We use a gradients operations to choose the element with maximum steepness, Figure 4 and 5.

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LP achieves entropy 8.67 and 9.58 and OPF achieves 10.47 and 11.40.

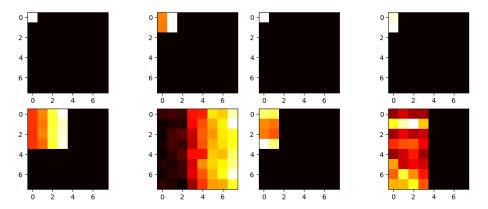


Fig. 4. Hierarchical 2D entropy after height gradient based shuffle and row random permutation for OPF 3754 (left) and LP OSA 07 (right).

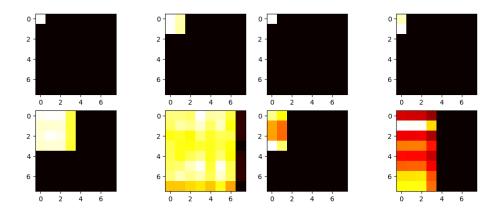


Fig. 5. Hierarchical 2D entropy after height and width gradient shuffle and row and column random permutation for OPF 3754 (left) and LP OSA 07 (right).

If the goal is to achieve a uniformly sparse matrix, it seems that we have the tools to compute and to measure such a sparsity. We admit that we do not try to find the best permutation. But our real goal is to create a work bench where randomization can be tested on different architectures and different algorithms. A randomization with a measurable uniform distribution is preferable than just random. We are interested to find out when random is enough or not enough. Also, consider that to achieve a uniform distribution, we do not need a random transformation and any permutation balancing the number of non-zero is possible, but for now not looked for.

6 MEASURING THE RANDOMIZATION EFFECTS

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Whether or not this ever applied to the reader, when we have timed algorithms (i.e., measure execution time), we came to expect variation. The introduction of randomization may hide behind the ever present variance, after all these are

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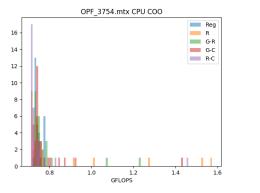
algorithms on *small* inputs: small error can be comparable to the overall execution time. Here, we must address this concern even before describing the experiments.

First, we execute every algorithm between 1000 and 5000 times. The time of each experiment is in the seconds, providing a granularity for which we are confident the measuring time error is under control. Thus, for each experiment we provide an average execution time: we measure the time and we divide by the number of trials. Cold starts, the first iteration, are still accounted. To make the measure portable across platform we present GFLOPS, that is, Giga (10^{12}) floating operations per second: 2*nnz divided by the average time in seconds.

Then we repeat the same experiment 32 times. Permutations in *numpy* Python uses a seed that is time sensitive: thus every experiment is independent from the previous. The number 32 is an old statistic trick and it is a minimum number of independent trials to approximate a normal distribution. In practice, they are not but the number is sufficient for most of the cases and it is an excellent starting point.

A short hand legend: **Reg** is the regular matrix without any permutation; **R** stands for random *Row* permutation; **G-R** stands for gradient-based row shuffle and random row permutation; **G-C** stands for gradient-based column shuffle and random column permutation; **R-C** stands for random row and column permutation. This legend is used in the pictures to be concise, in the tables in the following sections, we use a verbose description. We shall clarify the gradient based approach in the experimental results section 8. Intuitively, we help the random permutation by a quick targeting of high and low volume of the histogram (and thus the matrix).

In Figure 6, we show two plots respectively of the CPU performance using COO and CSR SpMV algorithms for the matrix OPF 3754. The figure represents histograms: The x is GFLOPS and the y label is the number of counts. Thus we show what is the performance distribution of an algorithm. We can see that the CSR algorithms are consistent and the Regular (i.e., the original) has always the best performance. Also the variance of the computation time is small and the shape is approximately Gaussian. Different story for the COO, the permutations introduce long tails, thus $2\times$ performance advantage.



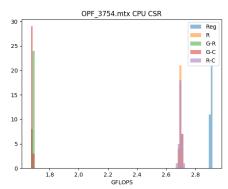


Fig. 6. CPU COO (left) and CPU CSR (left) for OPF 3754

If we take the original matrix and split into parts having the same number of rows, and execute them in parallel using different cores, we can see in Figure 7 that randomization is quite useful.

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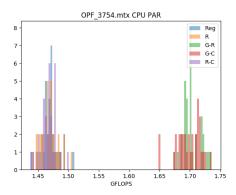
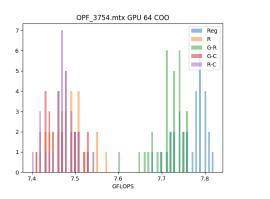


Fig. 7. Parallel CPU CSR for OPF 3754

In Figure 8, 9 and 10, randomization is harmful to the GPU implementation. The OPF 375 matrix is mostly diagonal, thus the vector \mathbf{x} is read in close quarters, randomization breaks it. If the load balance is fixed (i.e., by dividing the matrix by row and in equal row), randomization is beneficial.



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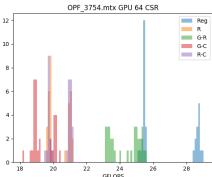


Fig. 8. Vega 20, GPU 64bits COO (left) and GPU CSR (right) for OPF 3754

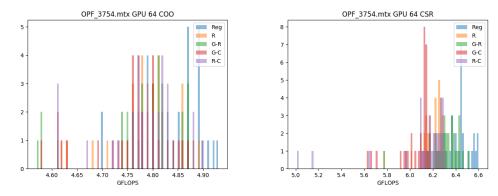


Fig. 9. Ellesmere, GPU 64bits COO (left) and GPU CSR (right) for OPF 3754

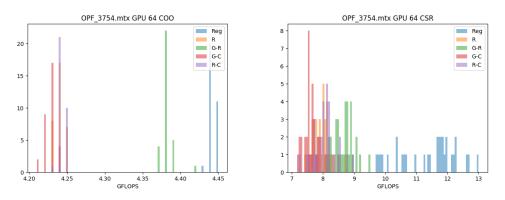


Fig. 10. Fiji, GPU 64bits COO (left) and GPU CSR (right) for OPF 3754

For matrix LP OSA 07, randomization helps clearly only for CPU CSR as we show in Figure 11. In Figure 12, 13, and 14, we can see that randomization is harmful but for one GPU, we can show that a single exception is possible (40% improvement).

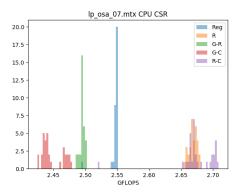


Fig. 11. CPU CSR for LP OSA 07

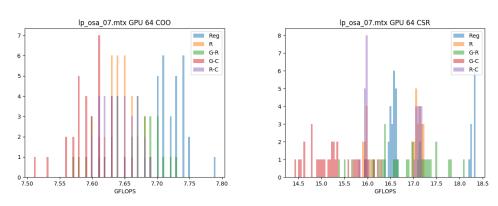


Fig. 12. Vega 20, GPU 64bits COO (left) and GPU CSR (right) for OPF 3754 $\,$

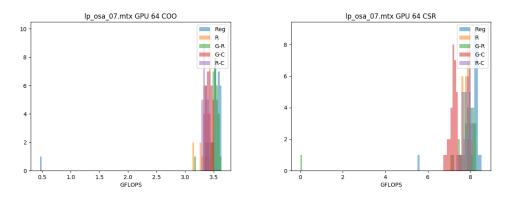
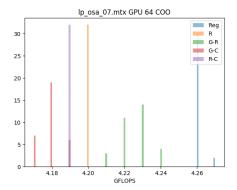


Fig. 13. Ellesmere, GPU 64bits COO (left) and GPU CSR (right) for OPF 3754



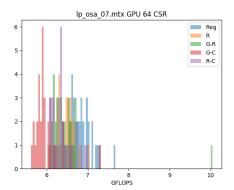
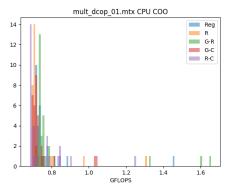


Fig. 14. Fiji, GPU 64bits COO (left) and GPU CSR (right) for OPF 3754

An example, the matrix MULT DCOP 01, is where randomization is useful for the CPU, GPU, and the parallel version Figure 15, 16 - 19 and the gains can be up to 10-15%. Consider, we can achieve these improvements without any insights to the architecture, the algorithms and their relationships.



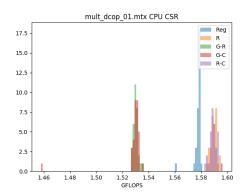


Fig. 15. CPU COO (left) and CPU CSR (right) for MULT DCOP 01

What does it mean when randomization does not work? The matrices we use in this work are not chosen randomly (pun not intended), they are the matrices that are difficult to handle in our custom SpMV engines using a combination of sorting networks and systolic arrays. If randomization does not work in our simplified work bench, will not work in our specialized architecture because the reorganization of the matrix or the input and output vector does not have the necessary parallelism, data locality, and data streaming. We need to do something else. In this case disrupting the memory pattern is not sufficient. Thus, if we cannot beat the pattern, we must exploit it, well not in this work.

7 WORKLOADS

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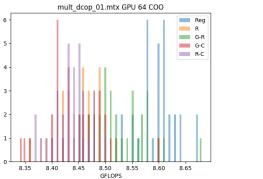
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In the previous sections, we defined what we mean for randomization and we present our tools of tricks for the measure of the effects of randomization. Here we describe the work loads, the applications, we use to test the effects of the randomization.



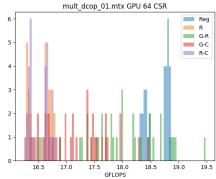
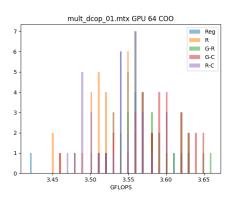


Fig. 16. Vega 20, GPU 64bits COO (left) and GPU CSR (right) for MULT DCOP 01



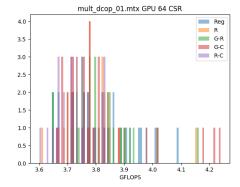
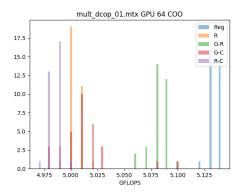


Fig. 17. Ellesmere, GPU 64bits COO (left) and GPU CSR (right) for MULT DCOP 01



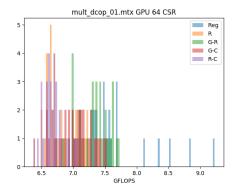


Fig. 18. Fiji, GPU 64bits COO (left) and GPU CSR (right) for MULT DCOP 01

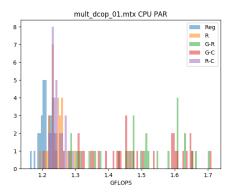


Fig. 19. Parallel CPU CSR for MULT DCOP 01

7.1 Python COO and CSR algorithms

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The simplicity to compute the SpMV by the code z = A * b in Python is very rewarding. By change of the matrix storage format, A = A.tocsr(); z = A * b, we have a different algorithm. The performance exploitation is moved to the lower level. The CSR implementation is often two times faster but there are edge cases where the COO and COO with randomization can go beyond and be surprisingly better: MUL DCOP 03 is an example where COO can do well.

Intuitively, Randomization can affect the performance because the basic implementation is a sorting algorithm and it is a fixed algorithm. There are many sorting algorithms and each can be optimal for a different initial distribution. If we knew what is the sorting algorithm we could tailor the input distribution. Here we just play with it.

In Section 8, we present all the results for CPU and GPUS. Keep in mind that these problems are hard, in the sense they do not have fancy performance sheets (these architectures can achieve Tera FLOPs sustained performance for dense computations). If we go through diligently, we can see that there is a 15x performance difference between the single thread CPU and Vega 20 GPU (i.e, 3 vs 40 GFLOPS).

7.2 Parallel CSR using up to 16 cores

Python provides the concept of Pool to exploit a naive parallel computation. We notice that work given to a Pool is split accordingly to the number of elements to separate HW cores. We also noticed that the work load move from a core to another, thus not ideal. Also we notice that Pool introduce a noticeable overhead: a Pool of 1, never achieves the performance of the single thread z = A * b. Using Pool allows us to investigate how a naive row partitioning without counting can scale up with number of cores. We tested by splitting the rows to 1–16 cores evenly (one thread per core) and we present the performance for only the best configuration. The randomization goal is to distribute the work uniformly: a balanced work distribution avoid the unfortunate case where a single core does all the work. We are pleased by the simplicity of the benchmark and we know we can do better.

7.3 GPU COO and CSR algorithms

In this work, we use AMD GPUs and *rocSPARSE* is their current software. The software has a few glitches but overall can be used for different generation of AMD GPUs. We use the COO and CSR algorithms and we provide performance measure for double precision only. The ideas of using different GPUs: it is important to verify that the randomization Manuscript submitted to ACM

can be applied independently of the HW. We are not here to compare performance across GPUs and CPUs. Often the limitation is the software, how the software can exploit the hardware or how the software will make easy to use a specific GPU. For example, the Fiji architecture is clearly superior to the Ellesmere, however the latter have better support and the system overall is more stable and user friendly.

The performance of the CSR algorithm is about two times faster than the COO. Most of the algorithms count the number of sparse elements in a row and thus they can decide the work load partition accordingly. Counting give you an edge but without changing the order of the computation there could be cases where the work load is not balanced and a little randomization could help and it does.

7.4 Randomization sometimes works

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For the majority of the cases we investigated and reported in the following sections, Randomization does not work.

However, there are cases where randomization does work and does work for different algorithms and architectures. If
you are in the business of preconditioning, permutations are pretty cheap. If you can find a good one just consider like
a preconditioning matrix, which it is.

This shows also that HW has to be more conscious, well the HW designer should, and accept that there are options at software level, at matrix level and beyond.

275 8 EXPERIMENTAL RESULTS

The main hardware setup is a AMD Threadripper with 16 cores. We have three Radeon GPUs: Vega 20 7nm, Pro 2xFiji, and Pro 2xEllesmere.

Vega 20 can deliver 3.5TFLOPS in double precision and it has 1TB/s HBM memory. Each Fiji provides 0.5 TFLOPS in double precision and has 512GB/s HBM, the card has two chips. The Ellesmere provides 0.3TFLOPS in double precision and has 224GB/s DDR5, the card has two chips. In the performance plots presented earlier and in the following, you will notice that the performance gap between these GPUs is not so marked. We can safely state that $vega \sim 2 \times Fiji$ and $Fiji \sim 2 \times ellesmere$

There are 4 basic randomization formats:

- Random Row Permutation, we take the original matrix and permute the rows.
- Random Row and Column Permutation, we take the original matrix and permute the rows and the columns.
- Gradient based row permutation, we compute the row histogram and we compute the gradient: $h_{i+1} h_i$. We find a single point where the gradient is maximum, this is the pivot for a shuffle like a magician would shuffle a deck of cards. Then we permute the two parts randomly.
- Gradient based row and column permutation, As above but also for the columns.

For large matrices (large number of columns and rows) a permutation tends to be a close variation of the original, still a random permutation. The gradient allows us to describe two areas of the original matrix where there is a clear and de-marked density variation: for example, there are two uniform distributed sub matrices but one denser than the other. A shuffle redistributes every other sample/card to different parts and these can be permuted locally.

We report in the following the performance results GFLOPS, we introduce a * following the best performance. This is tedious to read and, we assure, to write. The code and the results are available as software repository. Remember each experiment is based on 32 different runs and thus we report maximum, minimum, and mean as a summary. We use the symbol H for entropy.

298	9 VEGA VII A	AND THREADRIPPER	371	mult_dcop_02.mtx	
200			372	Regular	
299	mult_dcop_03.mtx		373		CPU COO min 1.615 max* 1.677 mean 1.652
300	Regular		374		CPU CSR min 1.539 max 1.579 mean 1.575
301		CPU COO min 0.728 max 0.880 mean 0.757	375		GPU 64 COO min 8.530 max* 8.700 mean 8.614
302		CPU CSR min 1.563 max 1.581 mean 1.577	376		CSR min 18.290 max 18.890 mean 18.597
303		GPU 64 COO min 8.540 max* 8.670 mean 8.619	377		CPU PAR min 1.120 max 1.248 mean 1.211
304		CSR min 18.320 max 18.930 mean 18.620	378		H min 9.689 max 9.689 mean 9.689
305		CPU PAR min 1.170 max 1.269 mean 1.226	379	Row-Premute	
306		H min 9.689 max 9.689 mean 9.689	380	now i i cinace	CPU COO min 0.684 max 0.780 mean 0.705
307	Row-Premute		381		CPU CSR min 1.558 max* 1.596 mean 1.588
308		CPU COO min 0.710 max 0.845 mean 0.724	382		GPU 64 COO min 8.360 max 8.490 mean 8.433
309		CPU CSR min 1.549 max* 1.597 mean 1.589	383		CSR min 16.240 max 16.750 mean 16.552
310		GPU 64 COO min 8.360 max 8.540 mean 8.442	384		CPU PAR min 1.182 max 1.277 mean 1.242
311		CSR min 16.260 max 16.780 mean 16.551			H min 10.737 max 10.742 mean 10.740
312		CPU PAR min 1.205 max 1.319 mean 1.263	385	D	n IIII 10.737 IIIax 10.742 IIIean 10.740
313		H min 10.737 max 10.742 mean 10.740	386	Row-Gradient	CPU COO min 0.704 max 1.373 mean 0.790
314	Row-Gradient		387		
315		CPU COO min 0.706 max 1.603 mean 0.806	388		CPU CSR min 1.518 max 1.535 mean 1.529
316		CPU CSR min 1.493 max 1.534 mean 1.528	389		GPU 64 COO min 8.420 max 8.590 mean 8.517
317		GPU 64 COO min 8.430 max 8.610 mean 8.527	390		CSR min 16.680 max*19.550 mean 17.907
318		CSR min 17.070 max*18.970 mean 18.115	391		CPU PAR min 1.328 max* 1.713 mean 1.484
319		CPU PAR min 1.331 max 1.695 mean 1.513	392		H min 10.572 max 10.585 mean 10.581
320		H min 10.576 max 10.585 mean 10.580	393	Column-Gradient	
321	Column-Gradient		394		CPU COO min 0.697 max 1.460 mean 0.742
322		CPU COO min 0.694 max* 1.632 mean 0.797	395		CPU CSR min 1.517 max 1.534 mean 1.527
323		CPU CSR min 1.491 max 1.534 mean 1.529	396		GPU 64 COO min 8.330 max 8.490 mean 8.420
324		GPU 64 COO min 8.350 max 8.520 mean 8.429	397		CSR min 16.020 max 18.390 mean 17.303
325		CSR min 15.970 max 18.180 mean 17.124	398		CPU PAR min 1.321 max 1.709 mean 1.557
			399		H min 10.823 max*10.843 mean 10.835
326		Gro Tritt III211 T.SET IIIGX: T.TEG IIICGIT T.STT	400	Row-Column-Permute	
327		H min 10.826 max*10.840 mean 10.833	401		CPU COO min 0.691 max 0.746 mean 0.698
328	Row-Column-Permute		402		CPU CSR min 1.568 max 1.595 mean 1.587
329		CPU COO min 0.688 max 0.757 mean 0.696	403		GPU 64 COO min 8.350 max 8.500 mean 8.436
330		CPU CSR min 1.490 max 1.595 mean 1.584	404		CSR min 16.250 max 16.780 mean 16.517
331		GPU 64 COO min 8.380 max 8.500 mean 8.445	405		CPU PAR min 1.187 max 1.280 mean 1.228
332		CSR min 16.230 max 16.780 mean 16.513	406		H min 10.739 max 10.743 mean 10.740
333		CPU PAR min 1.192 max 1.274 mean 1.237	407	lp_fit2d.mtx	
334		H min 10.737 max 10.742 mean 10.740	408	Regular	
335	mult_dcop_01.mtx		409		CPU COO min 0.774 max 0.804 mean 0.793
336	Regular		410		CPU CSR min 2.538 max 2.550 mean 2.547
337		CPU COO min 0.710 max 1.453 mean 0.761	411		GPU 64 COO min 7.060 max 7.170 mean 7.101
338		CPU CSR min 1.561 max 1.581 mean 1.578	412		CSR min 15.650 max*18.700 mean 18.031
339		GPU 64 COO min 8.520 max 8.670 mean 8.597	413		CPU PAR min 1.537 max 1.645 mean 1.590
340		CSR min 18.320 max 18.870 mean 18.636	414		H min 11.109 max 11.109 mean 11.109
341		CPU PAR min 1.163 max 1.246 mean 1.212		Davi Daamida	II IIII II.105 IIIAX II.105 IIIEAII II.105
342		H min 9.689 max 9.689 mean 9.689	415 416	Row-Premute	CPU COO min 0.740 max 0.776 mean 0.746
343	Row-Premute		417		
344		CPU COO min 0.699 max 1.305 mean 0.745			
345		CPU CSR min 1.585 max 1.597 mean 1.590	418		GPU 64 COO min 7.040 max* 7.180 mean 7.098 CSR min 15.690 max 18.580 mean 16.732
346		GPU 64 COO min 8.360 max 8.520 mean 8.446	419		
347		CSR min 16.260 max 16.780 mean 16.528	420		CPU PAR min 1.327 max 1.482 mean 1.422
348		CPU PAR min 1.192 max 1.298 mean 1.242	421	D C 17	H min 11.098 max 11.105 mean 11.101
349		H min 10.738 max 10.742 mean 10.740	422	Row-Gradient	CDU 000 0 700
350	Row-Gradient		423		CPU COO min 0.739 max* 2.092 mean 1.091
351		CPU COO min 0.709 max* 1.656 mean 0.819	424		CPU CSR min 2.539 max 2.546 mean 2.543
352		CPU CSR min 1.527 max 1.535 mean 1.530	425		GPU 64 COO min 7.040 max 7.150 mean 7.100
353		GPU 64 COO min 8.450 max* 8.680 mean 8.527	426		CSR min 15.520 max 18.560 mean 17.547
354		CSR min 16.520 max*19.480 mean 17.984	427		CPU PAR min 1.401 max 1.661 mean 1.525
355		CPU PAR min 1.280 max 1.704 mean 1.485	428		H min 11.109 max 11.109 mean 11.109
356		H min 10.572 max 10.585 mean 10.581	429	Column-Gradient	
357	Column-Gradient		430		CPU COO min 0.726 max 2.065 mean 1.011
358		CPU COO min 0.698 max 1.042 mean 0.737	431		CPU CSR min 2.539 max 2.550 mean 2.546
359		CPU CSR min 1.458 max 1.536 mean 1.528	432		GPU 64 COO min 6.800 max 7.140 mean 7.080
360		GPU 64 COO min 8.340 max 8.600 mean 8.443	433		CSR min 15.480 max 18.560 mean 16.866
361		CSR min 16.360 max 18.450 mean 17.247	434		CPU PAR min 1.391 max* 1.737 mean 1.563
362		CPU PAR min 1.307 max* 1.712 mean 1.494	435		H min 11.329 max 11.333 mean 11.331
363		H min 10.823 max*10.841 mean 10.835	436	Row-Column-Permute	
	Row-Column-Permute		437		CPU COO min 0.746 max 0.782 mean 0.754
364	vom-cornill-Letunte	CDII COO min A 692 may 1 347 2 740	438		CPU CSR min 3.310 max 3.324 mean 3.318
365		CPU COD min 0.683 max 1.247 mean 0.749	439		GPU 64 COO min 7.030 max 7.160 mean 7.100
366		CPU CSR min 1.583 max* 1.595 mean 1.590	440		CSR min 15.730 max 18.530 mean 17.362
367		GPU 64 COO min 8.370 max 8.500 mean 8.435	441		CPU PAR min 1.340 max 1.451 mean 1.401
368		CSR min 16.250 max 16.780 mean 16.518	442		H min 11.099 max 11.104 mean 11.102
369		CPU PAR min 1.206 max 1.291 mean 1.243	443	bloweya.mtx	
370		H min 10.738 max 10.742 mean 10.740	444	Regular	
				~	

445		CPU COO min 0.727 max* 1.815 mean 0.892	519	GPU 64 COO min 11.340 max*11.860 mean 11.441
446		CPU CSR min 2.867 max* 2.936 mean 2.917	520	CSR min 36.010 max*40.960 mean 38.048
447		GPU 64 COO min 0.000 max 0.000 mean 0.000	521	CPU PAR min 2.019 max 2.204 mean 2.130
448		CSR min 0.000 max 0.000 mean 0.000	522	H min 8.228 max 8.228 mean 8.228
449		CPU PAR min 1.680 max* 1.751 mean 1.719	523 Row-Premute	
450		H min 7.205 max 7.205 mean 7.205	524	CPU COO min 0.718 max 0.751 mean 0.732
451	Row-Premute		525	CPU CSR min 2.488 max 2.507 mean 2.498
452		CPU COO min 0.678 max 1.483 mean 0.746	526	GPU 64 COO min 10.810 max 11.090 mean 10.949
453		CPU CSR min 2.311 max 2.326 mean 2.320	527	CSR min 24.860 max 26.410 mean 25.527
454		GPU 64 COO min 6.840 max* 7.270 mean 6.930	528	CPU PAR min 1.978 max 2.290 mean 2.135
455		CSR min 15.650 max 16.800 mean 16.233	529	H min 11.836 max 11.840 mean 11.838
456		CPU PAR min 1.649 max 1.730 mean 1.682	530 Row-Gradient	
457		H min 11.026 max 11.031 mean 11.029	531	CPU COO min 0.722 max 1.794 mean 0.769
458	Row-Gradient		532	CPU CSR min 2.407 max 2.421 mean 2.416
459		CPU COO min 0.708 max 1.209 mean 0.779	533	GPU 64 COO min 11.210 max 11.480 mean 11.317
460		CPU CSR min 1.648 max 1.735 mean 1.709	534	CSR min 31.920 max 34.690 mean 33.246
461		GPU 64 COO min 6.920 max 7.080 mean 7.015	535	CPU PAR min 2.184 max* 2.302 mean 2.232
462		CSR min 16.950 max 19.500 mean 17.794	536	H min 10.742 max 10.757 mean 10.748
463		CPU PAR min 1.497 max 1.743 mean 1.608	537 Column-Gradient	
464		H min 10.298 max 10.304 mean 10.301	538	CPU COO min 0.720 max 0.916 mean 0.742
465	Column-Gradient		539	CPU CSR min 2.395 max 2.410 mean 2.402
466	COTUMNI OF BUTCHE	CPU COO min 0.709 max 1.536 mean 0.817	540	GPU 64 COO min 10.840 max 11.070 mean 10.946
467		CPU CSR min 1.705 max 1.753 mean 1.735	541	CSR min 24.340 max 26.140 mean 25.393
468		GPU 64 COO min 6.800 max 7.120 mean 6.865	542	CPU PAR min 2.184 max 2.272 mean 2.223
469		CSR min 15.480 max*17.710 mean 16.470	543	H min 11.873 max 11.882 mean 11.878
470		CPU PAR min 1.446 max 1.718 mean 1.591	544 Row-Column-Permute	
471		H min 10.880 max 10.886 mean 10.883	545	CPU COO min 0.707 max 0.748 mean 0.714
472	Row-Column-Permute		546	CPU CSR min 2.458 max 2.511 mean 2.506
473		CPU COO min 0.670 max 1.024 mean 0.706	547	GPU 64 COO min 10.880 max 11.070 mean 10.957
474		CPU CSR min 2.199 max 2.340 mean 2.326	548	CSR min 24.890 max 26.490 mean 25.642
475		GPU 64 COO min 6.880 max 6.980 mean 6.933	549	CPU PAR min 2.209 max 2.282 mean 2.240
476		CSR min 15.610 max 16.900 mean 16.227	550	H min 11.834 max*11.840 mean 11.838
477		CPU PAR min 1.598 max 1.668 mean 1.632	551 brainpc2.mtx	III III II. 054 max*II. 040 mean III. 050
478	1	H min 11.025 max*11.032 mean 11.029		CDU COO
479	lp_osa_07.mtx		553	CPU COO min 0.732 max 0.751 mean 0.744
480	Regular		554	CPU CSR min 2.885 max* 2.916 mean 2.909
481		CPU COO min 0.715 max 1.798 mean 0.885	555	GPU 64 COO min 0.000 max 0.000 mean 0.000
482		CPU CSR min 2.495 max 2.551 mean 2.547	556	CSR min 0.000 max 0.000 mean 0.000
483		GPU 64 COO min 7.650 max* 7.790 mean 7.718	557	CPU PAR min 1.276 max 1.299 mean 1.286
484		CSR min 16.390 max*18.350 mean 17.093	558	H min 7.478 max 7.478 mean 7.478
485		CPU PAR min 0.963 max 1.012 mean 0.995	559 Row-Premute	
486		H min 8.412 max 8.412 mean 8.412	560	CPU COO min 0.727 max 0.855 mean 0.736
487	Row-Premute		561	CPU CSR min 2.385 max 2.411 mean 2.397
488	NOW IT CINGE	CPU COO min 0.720 max* 2.078 mean 1.104	562	GPU 64 COO min 8.120 max 8.410 mean 8.206
489		CPU CSR min 2.656 max* 2.679 mean 2.669	563	CSR min 18.670 max 19.960 mean 19.536
490		GPU 64 COO min 7.610 max 7.690 mean 7.647	564	CPU PAR min 1.293 max 1.340 mean 1.314
491		CSR min 15.910 max 17.210 mean 16.750	565	H min 9.809 max 9.813 mean 9.811
492		CPU PAR min 0.890 max 0.940 mean 0.918	566 Row-Gradient	
493		H min 9.255 max 9.258 mean 9.256	567	CPU COO min 0.696 max* 1.546 mean 0.785
494	Row-Gradient		568	CPU CSR min 1.361 max 1.420 mean 1.411
495		CPU COO min 0.725 max 2.078 mean 1.041	569	GPU 64 COO min 8.190 max* 8.550 mean 8.302
496		CPU CSR min 2.487 max 2.502 mean 2.495	570	CSR min 18.700 max*21.000 mean 19.890
497		GPU 64 COO min 7.570 max 7.730 mean 7.655	571	CPU PAR min 1.435 max 1.666 mean 1.549
498		CSR min 15.370 max 18.100 mean 16.803	572	H min 9.721 max 9.727 mean 9.723
499		CPU PAR min 1.435 max 1.796 mean 1.592	573 Column-Gradient	
500		H min 8.637 max 8.678 mean 8.672	574	CPU COO min 0.698 max 1.467 mean 0.746
501	Column-Gradient	11 MILIT 0.057 Max 0.070 Medit 0.072	575	CPU CSR min 1.377 max 1.423 mean 1.414
	COTGHILL-OL BUTELL	CPU COO min 0.724 max 1.990 mean 1.000		GPU 64 COO min 8.110 max 8.290 mean 8.187
502			576	
503		CPU CSR min 2.425 max 2.477 mean 2.448	577	CSR min 18.090 max 20.190 mean 19.217
504		GPU 64 COO min 7.510 max 7.660 mean 7.596	578	CPU PAR min 1.345 max* 1.681 mean 1.518
505		CSR min 14.410 max 16.290 mean 15.267	579	H min 10.369 max*10.372 mean 10.370
506		CPU PAR min 1.238 max 1.774 mean 1.534	580 Row-Column-Permute	
507		H min 9.447 max* 9.603 mean 9.576	581	CPU COO min 0.698 max 1.390 mean 0.788
508	Row-Column-Permute		582	CPU CSR min 2.387 max 2.410 mean 2.399
509		CPU COO min 0.738 max 1.950 mean 1.071	583	GPU 64 COO min 8.120 max 8.260 mean 8.191
510		CPU CSR min 2.522 max 2.709 mean 2.675	584	CSR min 18.530 max 19.960 mean 19.307
511		GPU 64 COO min 7.600 max 7.690 mean 7.641	585	CPU PAR min 1.295 max 1.347 mean 1.319
		CSR min 15.820 max 17.190 mean 16.572		H min 9.809 max 9.813 mean 9.811
512			586	11 Heart 5.811 Closs Max 9.015 Mean 9.811
513			587 shermanACb.mtx	
514		H min 9.255 max 9.258 mean 9.256	588 Regular	
	ex19.mtx		589	CPU COO min 0.712 max 1.201 mean 0.756
515				
515 516	Regular		590	CPU CSR min 1.558 max 1.601 mean 1.596
		CPU COO min 0.732 max* 1.837 mean 1.076		
516		CPU COO min 0.732 max* 1.837 mean 1.076 CPU CSR min 2.563 max* 2.586 mean 2.577	590	CPU CSR min 1.558 max 1.601 mean 1.596

502		CPU PAR		1 206	. 1 511 .		1 447	667	Row-Premute	
593 594		H PAR		1.286 max 8.600 max				667 668	ROW-F1 elliute	CPU COO min 0.724 max 1.100 mean 0.765
595	Row-Premute	"	111111	0.000 1110	0.0001	ilean	0.000	669		CPU CSR min 2.581 max* 2.626 mean 2.609
596	NOW-F1 elliute	CPU COO	min	0.689 max	. a ona .	noan	0.704	670		GPU 64 COO min 7.170 max 7.340 mean 7.253
597		CPU CSR		1.600 max				671		CSR min 17.360 max 18.500 mean 18.014
598				7.000 max				672		CPU PAR min 1.494 max* 1.607 mean 1.558
599				15.760 max				673		H min 10.043 max 10.047 mean 10.044
600		CPU PAR		1.296 max				674	Row-Gradient	n IIIIn 10.043 IIIax 10.047 IIIean 10.044
601		H H		10.376 max				675	Now-di auteni	CPU COO min 0.716 max 1.701 mean 0.804
602	Row-Gradient		111211	10.570 11107	10.300 1	licari	10.373	676		CPU CSR min 1.824 max 1.840 mean 1.832
603	Now-Grautent	CPU COO	min	0.704 max	1 615 -	noan	a 0ac	677		GPU 64 COO min 7.220 max* 7.510 mean 7.303
604		CPU CSR		1.355 max				678		CSR min 17.540 max*20.710 mean 19.302
605				7.020 max				679		CPU PAR min 1.384 max 1.593 mean 1.526
606				0.000 max				680		H min 9.681 max 9.706 mean 9.694
607		CPU PAR		1.256 max				681	Column-Gradient	11 IIII1 5.001 IIIAX 5.700 IIIEAI1 5.054
608		H H		9.915 max				682	COTUMNI-GI AUTENC	CPU COO min 0.711 max 1.029 mean 0.746
609	Column-Gradient	"	IIIIII	3.313 IIIa)	3.3231	licali	3.321	683		CPU CSR min 1.817 max 1.834 mean 1.827
610	COTUMIN-OF AUTERIC	CPU COO	min	0.702 max	± 1 626 -	noan	0.011	684		GPU 64 COO min 7.110 max 7.270 mean 7.193
611		CPU CSR		1.327 max				685		CSR min 16.530 max 18.590 mean 17.574
612				6.920 max				686		CPU PAR min 1.390 max 1.574 mean 1.511
613				0.000 max				687		H min 10.612 max*10.659 mean 10.634
614		CPU PAR		1.283 max				688	Row-Column-Permute	11 III11 10.012 IIIax^10.039 IIIeai1 10.034
615		H		10.572 max				689	Now Column 1 crimate	CPU COO min 0.719 max 1.391 mean 0.756
616	Row-Column-Permute	"		10.372 11107	10.5551	licari	10.330	690		CPU CSR min 2.546 max 2.625 mean 2.611
617	Now Column Termace	CPU COO	min	0.707 max	1 532 r	noan	0 024	691		GPU 64 COO min 7.190 max 7.320 mean 7.248
618		CPU CSR		1.606 max				692		CSR min 17.500 max 18.640 mean 18.040
619				6.970 max				693		CPU PAR min 1.465 max 1.573 mean 1.533
620				15.850 max				694		H min 10.041 max 10.046 mean 10.044
621		CPU PAR		1.286 max				695	TSOPF_FS_b9_c6.mtx	11 IIII1 10.041 IIIAX 10.040 IIIEAN 10.044
622		H H		10.377 max				696	Regular	
623	cvxqp3.mtx	п	IIIII	10.3// IIIdx	10.302 1	llean	10.379	697	Regular	CPU COO min 0.705 max 0.734 mean 0.718
624	Regular							698		CPU CSR min 3.028 max* 3.052 mean 3.045
625	Regulai	CPU COO	min	0.697 max		noan	0.712	699		GPU 64 COO min 0.000 max 0.000 mean 0.000
626		CPU CSR		2.624 max				700		CSR min 0.000 max 0.000 mean 0.000
627				6.060 max				701		CPU PAR min 1.528 max* 1.602 mean 1.568
628				19.450 max				701		H min 7.380 max 7.380 mean 7.380
629		CPU PAR		1.733 max				702	Row-Premute	11 IIII1 7.360 IIIAX 7.360 IIIEAII 7.360
630		H		8.646 max				703	NOW-F1 elliute	CPU COO min 0.733 max 1.640 mean 0.777
631	Row-Premute	"	IIIIII	0.040 IIIax	0.0401	licali	0.040	704		CPU CSR min 2.450 max 2.543 mean 2.525
632	NOW-F1 elliute	CPU COO	min	0.695 max	± 1 577 -	noan	0.004	705		GPU 64 COO min 7.200 max 7.320 mean 7.268
633		CPU CSR		2.452 max				707		CSR min 17.420 max 18.540 mean 18.102
				5.870 max						CPU PAR min 1.474 max 1.595 mean 1.546
634 635				17.510 max				708 709		H min 10.042 max 10.046 mean 10.044
636		CPU PAR		1.723 max				710	Row-Gradient	11 III.11 10.042 III.03 10.040 III.031 10.044
637		H		11.028 max				711	Now-di auteni	CPU COO min 0.712 max 0.926 mean 0.750
638	Row-Gradient	"	IIIIII	11.020 1110	. 11.033 1	licali	11.030	711		CPU CSR min 1.819 max 1.846 mean 1.832
639	Now-Grautent	CPU COO	min	0.693 max	1 522 -	noan	A 700	712		GPU 64 COO min 7.210 max* 7.370 mean 7.298
640		CPU CSR		1.287 max				714		CSR min 17.550 max*20.740 mean 19.089
641				5.920 max				715		CPU PAR min 1.256 max 1.554 mean 1.495
642				16.810 max				716		H min 9.666 max 9.704 mean 9.690
643		CPU PAR		1.378 max				717	Column-Gradient	11 111 3.000 max 3.701 mcan 3.030
644		H		11.061 max				718	cordinir or adrene	CPU COO min 0.710 max* 1.690 mean 0.791
645	Column-Gradient							719		CPU CSR min 1.813 max 1.836 mean 1.830
646	COLUMN OF GULLET	CPU COO	min	0.693 max	1 521 r	nean	0 772	720		GPU 64 COO min 7.130 max 7.310 mean 7.211
647		CPU CSR		1.291 max				720		CSR min 16.550 max 18.690 mean 17.617
648				5.900 max				722		CPU PAR min 1.385 max 1.539 mean 1.506
649				16.620 max				723		H min 10.611 max*10.659 mean 10.634
650		CPU PAR		1.372 max				724	Row-Column-Permute	man recent maximum of the control of
651		Н		11.127 max				725	Non column i ci macc	CPU COO min 0.709 max 1.531 mean 0.963
652	Row-Column-Permute					cuii		726		CPU CSR min 2.506 max 2.648 mean 2.622
653	Now Column 1 Crimate	CPU COO	min	0.704 max	1 503 г	nean	0 875	727		GPU 64 COO min 7.140 max 7.330 mean 7.244
654		CPU CSR		2.447 max				727		CSR min 17.410 max 18.520 mean 18.148
655				5.880 max				729		CPU PAR min 1.466 max 1.574 mean 1.528
656				17.550 max				730		H min 10.041 max 10.046 mean 10.044
657		CPU PAR		1.639 max				731	OPF_6000.mtx	10.017
658		H		11.028 max				731	Regular	
659	case9.mtx			u				732	60101	CPU COO min 0.714 max 0.731 mean 0.720
660	Regular							734		CPU CSR min 2.667 max* 2.770 mean 2.720
661	60201	CPU COO	min	0.721 max	* 1.800 r	nean	1.177	734		GPU 64 COO min 12.310 max*12.550 mean 12.425
662		CPU CSR		3.021 max				736		CSR min 39.860 max*43.770 mean 42.075
663				0.000 max				737		CPU PAR min 1.735 max 1.945 mean 1.845
664				0.000 max				737		H min 8.799 max 8.799 mean 8.799
665		CPU PAR		1.508 max				739	Row-Premute	22 max 0.733 mcan 0.733
666		Н		7.380 max		nean	7.380	740	NOW I T CALLED	CPU COO min 0.689 max 0.710 mean 0.695

741		CPU CSR min 2.358 max 2.413 mean 2.392	815	CSR min 19.960 max 21.190 mean 20.696
742		GPU 64 COO min 11.430 max 11.770 mean 11.549	816	CPU PAR min 1.303 max 1.371 mean 1.345
743		CSR min 24.470 max 25.580 mean 24.785	817	H min 10.059 max 10.062 mean 10.061
744		CPU PAR min 1.758 max 1.896 mean 1.829	818 Row-Gradient	
745		H min 11.872 max 11.877 mean 11.875	819	CPU COO min 0.723 max 0.984 mean 0.753
746	Row-Gradient		820	CPU CSR min 1.781 max 1.809 mean 1.803
747		CPU COO min 0.716 max 0.775 mean 0.739	821	GPU 64 COO min 9.380 max 9.660 mean 9.464
748		CPU CSR min 1.651 max 1.689 mean 1.675	822	CSR min 15.770 max 19.090 mean 18.037
749		GPU 64 COO min 12.100 max 12.410 mean 12.205	823	CPU PAR min 1.775 max* 1.924 mean 1.868
750		CSR min 31.670 max 34.910 mean 33.370	824	H min 10.205 max 10.233 mean 10.219
751		CPU PAR min 2.079 max* 2.286 mean 2.207	825 Column-Gradie	
752		H min 11.111 max 11.116 mean 11.113	826 COTUMNITION AUTO	CPU COO min 0.715 max 0.926 mean 0.757
	0.1	n min II.III max II.II6 mean II.II3		
753	Column-Gradient		827	GI G GOR MILIT 11725 MAX 11002 MCGH 11751
754		CPU COO min 0.715 max* 1.021 mean 0.743	828	GPU 64 COO min 9.080 max 9.270 mean 9.158
755		CPU CSR min 1.655 max 1.674 mean 1.666	829	CSR min 13.980 max 15.780 mean 14.938
756		GPU 64 COO min 11.340 max 11.560 mean 11.463	830	CPU PAR min 1.751 max 1.906 mean 1.846
757		CSR min 23.770 max 25.470 mean 24.489	831	H min 11.213 max*11.232 mean 11.222
758		CPU PAR min 2.056 max 2.172 mean 2.118	832 Row-Column-Per	rmute
759		H min 12.040 max*12.047 mean 12.043	833	CPU COO min 0.732 max 1.598 mean 0.785
760	Row-Column-Permute		834	CPU CSR min 2.594 max 2.602 mean 2.599
761		CPU COO min 0.677 max 0.785 mean 0.687	835	GPU 64 COO min 9.340 max 9.460 mean 9.394
762		CPU CSR min 2.325 max 2.434 mean 2.369	836	CSR min 19.950 max 21.500 mean 20.544
763		GPU 64 COO min 11.450 max 11.650 mean 11.538	837	CPU PAR min 1.326 max 1.374 mean 1.354
764		CSR min 24.330 max 25.560 mean 25.008	838	H min 10.059 max 10.062 mean 10.061
765		CPU PAR min 1.631 max 1.776 mean 1.709	839 mhd4800a.mtx	11 10.005 max 10.002 mcan 10.001
766		H min 11.873 max 11.877 mean 11.875	840 Regular	
	005 2754	n III		CPU COO min 0.759 max 0.795 mean 0.780
767	OPF_3754.mtx		841	
768	Regular		842	CPU CSR min 2.479 max* 2.565 mean 2.557
769		CPU COO min 0.726 max 0.774 mean 0.747	843	GPU 64 COO min 5.490 max* 5.650 mean 5.552
770		CPU CSR min 2.898 max* 2.919 mean 2.908	844	CSR min 16.700 max 19.460 mean 18.004
771		GPU 64 COO min 7.680 max* 7.820 mean 7.766	845	CPU PAR min 1.456 max* 1.523 mean 1.492
772		CSR min 25.070 max*29.030 mean 26.756	846	H min 7.132 max 7.132 mean 7.132
773		CPU PAR min 1.437 max 1.508 mean 1.471	847 Row-Premute	
774		H min 8.393 max 8.393 mean 8.393	848	CPU COO min 0.695 max 0.943 mean 0.726
775	Row-Premute		849	CPU CSR min 2.480 max 2.488 mean 2.485
776		CPU COO min 0.714 max* 1.574 mean 0.817	850	GPU 64 COO min 5.410 max 5.490 mean 5.453
777		CPU CSR min 2.686 max 2.711 mean 2.699	851	CSR min 15.700 max 17.520 mean 16.678
778		GPU 64 COO min 7.410 max 7.570 mean 7.484	852	CPU PAR min 1.422 max 1.514 mean 1.474
779		CSR min 19.600 max 21.190 mean 20.307	853	H min 10.959 max 10.966 mean 10.963
780		CPU PAR min 1.443 max 1.505 mean 1.469	854 Row-Gradient	11 IIII 10.333 IIIAX 10.300 IIICAN 10.303
781			855	CPU COO min 0.723 max* 2.029 mean 0.990
		H min 11.267 max 11.272 mean 11.269		
782	Row-Gradient		856	CPU CSR min 2.411 max 2.427 mean 2.421
783		CPU COO min 0.723 max 1.232 mean 0.775	857	GPU 64 COO min 5.490 max 5.560 mean 5.534
784		CPU CSR min 1.672 max 1.691 mean 1.685	858	CSR min 16.350 max*19.560 mean 17.784
785		GPU 64 COO min 7.600 max 7.760 mean 7.716	859	CPU PAR min 1.441 max 1.509 mean 1.477
786		CSR min 23.160 max 25.590 mean 24.304	860	H min 9.512 max 9.526 mean 9.520
787		CPU PAR min 1.675 max* 1.736 mean 1.703	861 Column-Gradie	nt
788		H min 10.463 max 10.472 mean 10.468	862	CPU COO min 0.721 max 1.802 mean 0.871
789	Column-Gradient		863	CPU CSR min 2.393 max 2.408 mean 2.404
790		CPU COO min 0.726 max 1.431 mean 0.778	864	GPU 64 COO min 5.410 max 5.480 mean 5.453
791		CPU CSR min 1.671 max 1.685 mean 1.679	865	CSR min 15.680 max 17.870 mean 16.540
792		GPU 64 COO min 7.410 max 7.530 mean 7.467	866	CPU PAR min 1.429 max 1.488 mean 1.468
793		CSR min 18.140 max 20.350 mean 19.315	867	H min 10.931 max 10.945 mean 10.938
794		CPU PAR min 1.650 max 1.736 mean 1.699	868 Row-Column-Per	
795		H min 11.393 max*11.401 mean 11.397	869	CPU COO min 0.728 max 1.646 mean 1.037
796	Row-Column-Permute		870	CPU CSR min 2.472 max 2.488 mean 2.480
797	IIIIIII	CPU COO min 0.711 max 1.458 mean 0.751	871	GPU 64 COO min 5.410 max 5.480 mean 5.449
798		CPU CSR min 2.678 max 2.717 mean 2.700		
			872	CSR min 15.760 max 17.560 mean 16.654 CPU PAR min 1.428 max 1.513 mean 1.474
799		GPU 64 COO min 7.400 max 7.540 mean 7.471	873	
800		CSR min 19.560 max 21.150 mean 20.453	874	H min 10.959 max*10.967 mean 10.963
801		CPU PAR min 1.440 max 1.499 mean 1.467	875 gen4.mtx	
802		H min 11.266 max 11.272 mean 11.269	876 Regular	
803	c-47.mtx		877	CPU COO min 0.737 max 1.977 mean 1.431
804	Regular		878	CPU CSR min 2.674 max 2.688 mean 2.681
805		CPU COO min 0.754 max* 1.829 mean 1.204	879	GPU 64 COO min 5.900 max 6.000 mean 5.954
806		CPU CSR min 2.610 max* 2.624 mean 2.618	880	CSR min 13.650 max 15.410 mean 14.657
807		GPU 64 COO min 9.530 max* 9.870 mean 9.640	881	CPU PAR min 1.468 max 1.521 mean 1.491
808		CSR min 23.990 max*25.910 mean 24.992	882	H min 9.234 max 9.234 mean 9.234
809		CPU PAR min 1.311 max 1.380 mean 1.357	883 Row-Premute	
810		H min 8.364 max 8.364 mean 8.364	884	CPU COO min 0.740 max* 2.048 mean 1.121
811	Row-Premute	man 0.501 max 0.504 medil 0.504	885	CPU CSR min 2.777 max 2.798 mean 2.790
812	NOW I I CHICLE	CPU COO min 0.740 max 0.885 mean 0.755	886	GPU 64 COO min 5.910 max 5.970 mean 5.944
813		CPU COU min 0.740 max 0.885 mean 0.755 CPU CSR min 2.574 max 2.611 mean 2.597		
			887	CSR min 13.700 max 15.370 mean 14.541
814		GPU 64 COO min 9.320 max 9.510 mean 9.397	888	CPU PAR min 1.468 max 1.546 mean 1.502

889		Н	min	10.250 max	10.255	mean	10.252	963		CPU CO		0.735	max	1.806 n	nean	0.878
890	Row-Gradient							964		CPU CSI	R mir	2.706	max :	2.744 п	nean	2.726
891		CPU COO	min	0.740 max	1.790	mean	0.994	965		GPU 64	COO mir	6.390	max (5.500 п	nean	6.433
892		CPU CSR	min	2.663 max	2.682	mean	2.674	966			CSR mir	19.780	max 2	2.870 п	nean 2	20.936
893		GPU 64 COO	min	5.890 max	* 6.160	mean	5.946	967		CPU PAI	R mir	1.710	max	1.865 m	nean	1.785
894		CSR	min	13.780 max	*17.520	mean	15.601	968		Н	mir	10.251	max 10	0.267 n	nean 1	10.257
895		CPU PAR		1.479 max				969	Column-Gradient							
896		Н		9.939 max				970		CPU CO	n mir	0.728	may	1 792 n	nean	0 986
897	Column-Gradient			3.333 max	3.300	mean	3.3.0	971		CPU CSI		2.521				
898	COTUMNI-OF AUTERIC	CPU COO		0.742	1 001		0.001									
				0.743 max				972		GPU 64		6.280				
899		CPU CSR		2.620 max				973				18.000				
900				5.840 max				974		CPU PAI		1.649				
901		CSR	min	13.130 max	17.040	mean	15.008	975		Н	mir	11.113	max 1	1.121 n	nean 1	11.117
902		CPU PAR	min	1.477 max	1.607	mean	1.559	976	Row-Column-Permute							
903		Н	min	10.858 max	*10.876	mean	10.864	977		CPU CO	O mir	0.714	max	1.525 n	nean	0.957
904	Row-Column-Permute							978		CPU CSI	R mir	2.876	max :	2.892 n	nean	2.884
905		CPU COO	min	0.742 max	2.010	mean	1.124	979		GPU 64	COO mir	6.280	max (5.370 п	nean	6.322
906		CPU CSR		2.789 max				980		0.00.		17.960				
907		010 0010		5.900 max				981		CPII PAI		1.667				
										0.0.70						
908				13.640 max				982		Н	mır	11.162	max*1	1.168 m	nean	11.165
909		CPU PAR		1.462 max				983	TSOPF_RS_b39_c7.mtx							
910		Н	min	10.250 max	10.253	mean	10.252	984	Regular							
911	Maragal_6.mtx							985		CPU CO	O mir	0.771	max (0.793 п	nean	0.780
912	Regular							986		CPU CSI	R mir	3.219	max*	3.232 п	nean	3.227
913		CPU COO	min	0.725 max	0.741	mean	0.729	987		GPU 64	COO mir	11.070	max*1	1.200 n	nean 1	11.142
914		CPU CSR	min	2.345 max	2.409	mean	2.372	988			CSR mir	37.050	max*4	2.100 п	nean :	39.040
915				18.200 max				989		CPU PAI		1.910				
916				38.310 max				990		Н		7.304				
										п	IIIII	1 7.304	Illax	. 304 11	llean	7.304
917		CPU PAR		0.789 max				991	Row-Premute							
918		Н	min	9.930 max	9.930	mean	9.930	992		CPU CO		0.701				
919	Row-Premute							993		CPU CSI	R mir	2.931	max :	2.952 m	nean	2.942
920		CPU COO	min	0.709 max	0.779	mean	0.715	994		GPU 64	COO mir	10.860	max 1	1.030 п	nean 1	10.928
921		CPU CSR	min	2.675 max	2.715	mean	2.696	995			CSR mir	28.730	max 3	0.880 п	nean 2	29.483
922		GPU 64 COO	min	17.810 max	18.030	mean	17.935	996		CPU PAI	R mir	1.760	max	1.922 п	nean	1.851
923		CSR	min	29.650 max	30.580	mean	30.109	997		н	mir	10.537	max 10	Э.541 п	nean 1	10.539
924		CPU PAR		0.857 max				998	Row-Gradient							
925		H		10.777 max				999	now or duterie	CPU CO	n mi.	0.747	may /	000 -	maan	A 757
		п	IIIII	10./// IIIax	10.779	illean	10.776									
926	Row-Gradient							1000		CPU CSI		2.606				
927		CPU COO		0.710 max				1001		GPU 64		10.850				
928		CPU CSR	min	2.042 max	2.159	mean	2.120	1002			CSR mir	33.910	max 3	7.600 п	nean 3	35.909
929		GPU 64 C00	min	18.460 max	*18.960	mean	18.665	1003		CPU PAI	R mir	2.154	max*	2.245 п	nean	2.203
930		CSR	min	25.650 max	27.330	mean	26.549	1004		H	mir	9.636	max !	9.646 п	nean	9.642
931		CPU PAR	min	2.257 max	2.612	mean	2.416	1005	Column-Gradient							
932		Н	min	11.251 max	11.301	mean	11.285	1006		CPU CO	O mir	0.718	max*	1.693 n	nean	0.802
933	Column-Gradient			TTTLOT IIIGA		mean		1007		CPU CSI		2.502				
934	COTAMIN GLAGIETTE	CPU COO		0.711 max	0.742		0.725	1007				10.700				
										GPU 64						
935		CPU CSR		2.036 max				1009				27.230				
936				17.840 max				1010		CPU PAI		2.128				
937		CSR	min	19.410 max	20.690	mean	20.066	1011		Н	mir	11.131	max*1	1.222 n	nean 1	11.208
938		CPU PAR	min	2.174 max	* 2.546	mean	2.349	1012	Row-Column-Permute							
939		Н	min	12.011 max	*12.072	mean	12.052	1013		CPU CO	O mir	0.709	max (9.726 п	nean	0.716
940	Row-Column-Permute							1014		CPU CSI	R mir	2.917	max :	2.958 m	nean	2.940
941		CPU COO	min	0.712 max	0.971	mean	0.737	1015		GPU 64	COO mir	10.840	max 1	1.030 m	nean 1	10.930
942		CPU CSR	min	2.732 max	* 2,751	mean	2.743	1016				28.780				
943				17.720 max				1017		CPU PAI		1.757				
944				29.600 max				1018		Н	mır	10.537	IIIdX 1	0.540 N	nean 1	1W. D39
945		CPU PAR		0.827 max												
946		Н	min	10.776 max	10.778	mean	10.777									
947	aft01.mtx								10 ELLESME	DE						
948	Regular							1019	10 ELLESME	KE						
949		CPU COO	min	0.735 max	* 2.079	mean	1.069	1020	aft01.mtx							
950		CPU CSR		3.132 max				1021	Regular							
951				6.390 max					regutai	CDII C1	coc	4 000	marri	1 200 -		4 100
				19.990 max				1022		GPU 64		4.080				
952								1023				9.660				
953				1.746 max				1024		Н	mir	7.811	max	7.811 n	nean	7.811
954		Н	min	7.811 max	7.811	mean	7.811	1025	Row-Premute							
955	Row-Premute							1026		GPU 64	COO mir	3.860	max 4	1.090 п	nean	4.001
956		CPU COO	min	0.714 max	1.648	mean	0.840	1027			CSR mir	9.520	max 1	Э.340 п	nean	9.936
957		CPU CSR	min	2.864 max	2.892	mean	2.883	1028		Н		11.161				
958		GPU 64 COO		6.280 max				1029	Row-Gradient							
959				17.980 max				1029	or describ	CPII 64	COO ====	4 010	may	1 2/10 -	1025	A 125
				1.729 max				1030		GPU 64		4.010				
960											LOK Mir				mean .	6.882
961		Н		11.162 max				1032		Н		10.246				10.256
961 962	Row-Gradient								Column-Gradient	Н						10.256

1034		GPU 64 COO min 3.850 max 4.100 mean 4.012	1108	H min 7.380 max 7.380 mean 7.380
1035		CSR min 5.460 max 8.790 mean 6.005	1109 Row-Premute	CPU 64 000 min 4 000 min 4 040 min 4 050
1036	Daw Caluma Damusta	H min 11.112 max 11.122 mean 11.117	1110	GPU 64 COO min 4.820 max 4.940 mean 4.859 CSR min 5.080 max 6.520 mean 6.342
1037 1038	Row-Column-Permute	GPU 64 COO min 3.850 max 4.080 mean 3.990	1111 1112	H min 10.042 max 10.047 mean 10.044
1039		CSR min 5.420 max 6.760 mean 5.977	1113 Row-Gradient	11 IIII 10.042 IIIAX 10.047 IIICAN 10.044
1040		H min 11.162 max*11.169 mean 11.165	1114	GPU 64 COO min 4.810 max* 4.940 mean 4.876
1041	bloweya.mtx		1115	CSR min 6.100 max* 6.560 mean 6.307
1042	Regular		1116	H min 9.681 max 9.704 mean 9.694
1043		GPU 64 COO min 0.000 max 0.000 mean 0.000	1117 Column-Gradient	
1044		CSR min 0.000 max 0.000 mean 0.000	1118	GPU 64 COO min 4.810 max 4.930 mean 4.869
1045		H min 7.205 max 7.205 mean 7.205	1119	CSR min 4.820 max 6.460 mean 6.208
1046	Row-Premute		1120	H min 10.554 max*10.661 mean 10.638
1047		GPU 64 COO min 3.800 max 3.940 mean 3.875	1121 Row-Column-Permute	
1048		CSR min 3.710 max 4.570 mean 4.399	1122	GPU 64 COO min 4.810 max 4.940 mean 4.864
1049		H min 11.025 max 11.031 mean 11.028	1123	CSR min 5.930 max 6.520 mean 6.379
1050	Row-Gradient	GPU 64 COO min 3.800 max* 4.120 mean 3.962	1124	H min 10.041 max 10.047 mean 10.044
1051 1052		CSR min 4.340 max* 4.120 mean 3.962	1125 cvxqp3.mtx 1126 Regular	
1052		H min 10.296 max 10.307 mean 10.300	1127 Regular	GPU 64 COO min 3.350 max* 3.590 mean 3.483
1054	Column-Gradient	11 III 10.236 IIIAX 10.367 IIICAN 10.366	1128	CSR min 5.430 max* 9.260 mean 8.333
1055	COLUMN OF GULLITE	GPU 64 COO min 3.880 max 4.100 mean 3.978	1129	H min 8.646 max 8.646 mean 8.646
1056		CSR min 4.240 max 4.570 mean 4.412	1130 Row-Premute	
1057		H min 10.881 max 10.886 mean 10.883	1131	GPU 64 COO min 3.230 max 3.480 mean 3.371
1058	Row-Column-Permute		1132	CSR min 7.560 max 8.220 mean 7.900
1059		GPU 64 COO min 3.800 max 3.980 mean 3.885	1133	H min 11.027 max 11.033 mean 11.030
1060		CSR min 4.130 max 4.540 mean 4.399	1134 Row-Gradient	
1061		H min 11.025 max*11.033 mean 11.029	1135	GPU 64 COO min 3.240 max 3.510 mean 3.396
1062	brainpc2.mtx		1136	CSR min 6.990 max 7.890 mean 7.574
1063	Regular		1137	H min 11.060 max 11.069 mean 11.064
1064		GPU 64 COO min 0.000 max 0.000 mean 0.000	1138 Column-Gradient	
1065		CSR min 0.000 max 0.000 mean 0.000	1139	GPU 64 COO min 3.240 max 3.480 mean 3.374
1066	D D	H min 7.478 max 7.478 mean 7.478	1140	CSR min 6.980 max 7.900 mean 7.557
1067 1068	Row-Premute	GPU 64 COO min 3.840 max* 6.750 mean 4.110	1141 1142 Row-Column-Permute	H min 11.126 max*11.134 mean 11.130
1069		CSR min 4.260 max* 4.500 mean 4.437	1143	GPU 64 COO min 3.110 max 3.470 mean 3.365
1070		H min 9.809 max 9.813 mean 9.811	1144	CSR min 4.810 max 8.210 mean 7.742
1071	Row-Gradient		1145	H min 11.026 max 11.032 mean 11.030
1072		GPU 64 COO min 0.640 max 4.030 mean 3.864	1146 ex19.mtx	
1073		CSR min 4.270 max 4.470 mean 4.383	1147 Regular	
1074		H min 9.722 max 9.727 mean 9.724	1148	GPU 64 COO min 2.450 max* 2.610 mean 2.564
1075	Column-Gradient		1149	CSR min 4.490 max 4.760 mean 4.714
1076		GPU 64 COO min 0.640 max 4.070 mean 3.898	1150	H min 8.228 max 8.228 mean 8.228
1077		CSR min 4.230 max 4.500 mean 4.386	1151 Row-Premute	
1078		H min 10.368 max*10.372 mean 10.370	1152	GPU 64 COO min 2.000 max 2.040 mean 2.021
1079	Row-Column-Permute		1153	CSR min 4.640 max 4.780 mean 4.733
1080		GPU 64 COO min 3.980 max 4.110 mean 4.027	1154	H min 11.835 max 11.840 mean 11.838
1081		CSR min 4.320 max 4.490 mean 4.437 H min 9.809 max 9.813 mean 9.811	1155 Row-Gradient	CDII 64 COO min 2 240 mm 2 200 mm 2 220
1082 1083	c-47.mtx	n IIII 9.809 IIIAX 9.813 IIIEAN 9.811	1156 1157	GPU 64 COO min 2.240 max 2.390 mean 2.329 CSR min 4.570 max* 4.850 mean 4.807
1084	Regular		1158	H min 10.742 max 10.752 mean 10.747
1085	regular	GPU 64 COO min 3.980 max* 4.080 mean 4.026	1159 Column-Gradient	ii iii ii
1086		CSR min 4.760 max 4.850 mean 4.812	1160	GPU 64 COO min 2.010 max 2.050 mean 2.034
1087		H min 8.364 max 8.364 mean 8.364	1161	CSR min 4.570 max 4.760 mean 4.701
1088	Row-Premute		1162	H min 11.872 max*11.881 mean 11.878
1089		GPU 64 COO min 3.880 max 4.010 mean 3.942	1163 Row-Column-Permute	
1090		CSR min 4.040 max 4.900 mean 4.807	1164	GPU 64 COO min 2.000 max 2.040 mean 2.023
1091		H min 10.059 max 10.063 mean 10.061	1165	CSR min 0.770 max 4.780 mean 4.594
1092	Row-Gradient		1166	H min 11.835 max 11.840 mean 11.838
1093		GPU 64 COO min 3.900 max 4.050 mean 3.976	1167 gen4.mtx	
1094		CSR min 4.380 max 4.740 mean 4.630	1168 Regular	
1095	0.1	H min 10.201 max 10.228 mean 10.214	1169	GPU 64 COO min 4.880 max 4.980 mean 4.900 CSR min 10.020 max*11.300 mean 10.716
1096 1097	Column-Gradient	GPU 64 COO min 3.860 max 3.990 mean 3.936	1170 1171	H min 9.234 max 9.234 mean 9.234
1097		CSR min 4.350 max 4.610 mean 4.525	1172 Row-Premute	11 IIII11 9.234 IIIAX 9.234 IIIEAI1 9.234
1099		H min 11.204 max*11.241 mean 11.222	1173	GPU 64 COO min 4.860 max 4.930 mean 4.890
1100	Row-Column-Permute		1174	CSR min 0.330 max 11.200 mean 10.038
1101		GPU 64 COO min 3.890 max 4.020 mean 3.953	1175	H min 10.249 max 10.254 mean 10.252
1102		CSR min 4.490 max* 4.920 mean 4.840	1176 Row-Gradient	
1103		H min 10.058 max 10.063 mean 10.061	1177	GPU 64 COO min 4.860 max* 4.990 mean 4.908
1104	case9.mtx		1178	CSR min 9.160 max 11.240 mean 10.435
1105	Regular		1179	H min 9.939 max 9.961 mean 9.947
1106		GPU 64 COO min 0.000 max 0.000 mean 0.000	1180 Column-Gradient	
			1100 COTUMN OF BUTCHE	
1107		CSR min 0.000 max 0.000 mean 0.000	1181	GPU 64 COO min 4.780 max 4.880 mean 4.816

1182		CSR min 7.770 max 10.570 mean 9.407	1256 Row-Premute	
1183		H min 10.851 max*10.876 mean 10.864	1256 ROW-PT elliute	GPU 64 COO min 4.420 max 4.520 mean 4.445
1184	Row-Column-Permute	11 IIII1 10.631 IIIax×10.870 IIIeaii 10.804	1258	CSR min 10.520 max 10.880 mean 10.696
1185	NOW-COTUMIN-FEI MULE	GPU 64 COO min 4.850 max 4.950 mean 4.886	1259	H min 10.960 max*10.968 mean 10.963
1186		CSR min 10.220 max 11.280 mean 10.748	1260 Row-Gradient	11 IIII 10.500 IIIAX^10.500 IIIEAI 10.503
1187		H min 10.250 max 10.255 mean 10.252	1261	GPU 64 COO min 4.570 max 4.690 mean 4.605
1188	lp_fit2d.mtx	11 III11 10.230 IIIax 10.233 IIIeaii 10.232	1262	CSR min 4.550 max 13.350 mean 12.479
1189	Regular		1263	H min 9.508 max 9.527 mean 9.520
1190	Negatai	GPU 64 COO min 4.360 max* 4.640 mean 4.515	1264 Column-Gradient	11 IIII 3.300 IIIAX 3.327 IIICAN 3.320
1191		CSR min 10.080 max 10.900 mean 10.491	1265	GPU 64 COO min 4.430 max 4.530 mean 4.461
1192		H min 11.109 max 11.109 mean 11.109	1266	CSR min 10.250 max 10.940 mean 10.603
1193	Row-Premute	II IIIII II.103 IIIax II.103 IIIeaii II.103	1267	H min 10.934 max 10.945 mean 10.939
1194	NOW-F1 elliute	GPU 64 COO min 4.170 max 4.630 mean 4.476	1268 Row-Column-Permute	11 IIII 10.534 IIIAX 10.543 IIIEAN 10.535
1195		CSR min 0.910 max 10.910 mean 10.257	1269 ROW-COTUMNT-PET MICE	GPU 64 COO min 4.420 max 4.520 mean 4.450
1196		H min 11.098 max 11.104 mean 11.101	1270	CSR min 7.380 max 10.900 mean 10.598
1197	Row-Gradient	11 IIII1 11.030 IIIAX 11.104 IIIEAN 11.101	1270	H min 10.959 max 10.967 mean 10.963
1198	NOW-GI AUTEIIC	GPU 64 COO min 4.370 max 4.630 mean 4.529	1272 mult_dcop_01.mtx	11 IIII1 10.555 IIIAX 10.507 IIIEAI1 10.503
1199		CSR min 10.030 max 10.970 mean 10.624	1273 Regular	
1200		H min 11.109 max 11.109 mean 11.109	1274 Regulai	GPU 64 COO min 3.420 max 3.630 mean 3.555
1200	Column-Gradient	II IIIII II.103 IIIax II.103 IIIeaii II.103	1275	CSR min 3.650 max 4.090 mean 3.814
1201	COTUMNI-OF AUTERIC	GPU 64 COO min 4.250 max 4.640 mean 4.499	1276	H min 9.689 max 9.689 mean 9.689
1202		CSR min 8.510 max*11.010 mean 10.505	1277 Row-Premute	11 IIII1 3.003 IIIAX 3.003 IIIEAI1 3.003
1204		H min 11.328 max*11.333 mean 11.331	1278	GPU 64 COO min 3.450 max 3.580 mean 3.521
1205	Row-Column-Permute	11 11.520 max*11.555 mean 11.551	1279	CSR min 3.610 max 4.150 mean 3.785
1206	Now Column Termate	GPU 64 COO min 4.350 max 4.640 mean 4.511	1280	H min 10.738 max 10.742 mean 10.740
1207		CSR min 10.040 max 10.790 mean 10.468	1281 Row-Gradient	11 IIII 10.730 IIIAX 10.742 IIICAN 10.740
1208		H min 11.097 max 11.106 mean 11.101	1282	GPU 64 COO min 3.510 max* 3.660 mean 3.579
1209	lp_osa_07.mtx	II IIIII II.057 IIIAX II.100 IIIEAII II.101	1283	CSR min 3.650 max 4.160 mean 3.806
1210	Regular		1284	H min 10.576 max 10.585 mean 10.580
1211	Regulai	GPU 64 COO min 0.460 max* 3.640 mean 3.456	1285 Column-Gradient	11 IIII 10.570 IIIAX 10.565 IIIEAN 10.560
1211		CSR min 5.570 max* 8.530 mean 8.106	1286	GPU 64 COO min 3.460 max 3.650 mean 3.584
1213		H min 8.412 max 8.412 mean 8.412	1287	CSR min 3.660 max* 4.240 mean 3.799
1213	Row-Premute	11 IIII1 0.412 IIIax 0.412 IIIean 0.412	1288	H min 10.826 max*10.842 mean 10.836
1215	Now 11 clided	GPU 64 COO min 3.140 max 3.450 mean 3.367	1289 Row-Column-Permute	11 IIII 10.020 IIIAX*10.042 IIICAN 10.030
1216		CSR min 7.600 max 8.070 mean 7.853	1290	GPU 64 COO min 3.470 max 3.580 mean 3.532
1217		H min 9.255 max 9.258 mean 9.256	1291	CSR min 3.600 max 3.980 mean 3.743
1218	Row-Gradient	11 1111 J.233 max J.230 mean J.230	1292	H min 10.738 max 10.742 mean 10.740
1219	NOW Gradient	GPU 64 COO min 3.190 max 3.610 mean 3.509	1293 mult_dcop_02.mtx	11 IIII 10.730 IIIAX 10.742 IIICAN 10.740
1220		CSR min 0.000 max 8.260 mean 7.597	1294 Regular	
1221		H min 8.583 max 8.678 mean 8.670	1295 Regulai	GPU 64 COO min 3.390 max 3.660 mean 3.585
1222	Column-Gradient	11 1111 0.303 max 0.070 mean 0.070	1296	CSR min 0.960 max 4.330 mean 4.162
1223	COTUMNI-OF AUTERIC	GPU 64 COO min 3.330 max 3.500 mean 3.416	1297	H min 9.689 max 9.689 mean 9.689
1224		CSR min 6.730 max 7.540 mean 7.199	1298 Row-Premute	11 IIII1 3.003 IIIAX 3.003 IIIEAI1 3.003
1225		H min 9.542 max* 9.604 mean 9.581	1299	GPU 64 COO min 3.310 max 3.600 mean 3.488
1226	Row-Column-Permute	11 1111 3.342 max 3.004 mean 3.301	1300	CSR min 0.620 max 4.290 mean 4.132
1227	NOW-COTUMIN-FEI MULE	GPU 64 COO min 3.290 max 3.430 mean 3.365	1301	H min 10.738 max 10.743 mean 10.740
1228		CSR min 7.390 max 8.060 mean 7.832	1302 Row-Gradient	11 IIII 10.730 IIIAX 10.743 IIICAN 10.740
1229		H min 9.255 max 9.258 mean 9.256	1303	GPU 64 COO min 3.310 max* 3.670 mean 3.593
1230	Maragal_6.mtx		1304	CSR min 4.130 max* 4.430 mean 4.331
1231	Regular		1305	H min 10.576 max 10.584 mean 10.580
1232	negazar	GPU 64 COO min 4.160 max 4.310 mean 4.217	1306 Column-Gradient	11 10.570 max 10.501 mcan 10.500
1233		CSR min 4.940 max 4.960 mean 4.956	1307	GPU 64 COO min 0.550 max 3.660 mean 3.486
1234		H min 9.930 max 9.930 mean 9.930	1308	CSR min 3.890 max 4.410 mean 4.275
1235	Row-Premute	2.22 Max 3.330 Mcail 3.330	1309	H min 10.831 max*10.843 mean 10.836
1236		GPU 64 COO min 4.220 max 4.240 mean 4.225	1310 Row-Column-Permute	
1237		CSR min 4.750 max*13.040 mean 5.133	1311	GPU 64 COO min 3.470 max 3.590 mean 3.542
1238		H min 10.776 max 10.778 mean 10.777	1312	CSR min 4.190 max 4.290 mean 4.242
1239	Row-Gradient	11 10:770 max 10:770 mcan 10:777	1313	H min 10.738 max 10.742 mean 10.740
1240	now or durent	GPU 64 COO min 4.180 max* 4.450 mean 4.245	1314 mult_dcop_03.mtx	11 10.730 max 10.712 mcdil 10.710
1241		CSR min 4.880 max 4.940 mean 4.915	1315 Regular	
1242		H min 11.259 max*11.302 mean 11.281	1316	GPU 64 COO min 3.360 max* 3.660 mean 3.550
1243	Column-Gradient	III TTT ESS MAX TTT SOL MEAN TTT EST	1317	CSR min 3.650 max 4.090 mean 3.813
1244		GPU 64 COO min 4.200 max 4.250 mean 4.236	1318	H min 9.689 max 9.689 mean 9.689
1245		CSR min 4.800 max 4.890 mean 4.859	1319 Row-Premute	1.111 max 3.003 mcan 3.003
1246		H min 12.022 max 12.073 mean 12.051	1320	GPU 64 COO min 3.450 max 3.580 mean 3.521
1247	Row-Column-Permute		1321	CSR min 3.610 max 4.160 mean 3.784
1248		GPU 64 COO min 4.210 max 4.230 mean 4.222	1322	H min 10.738 max 10.743 mean 10.740
1249		CSR min 4.860 max 4.890 mean 4.887	1323 Row-Gradient	
1250		H min 10.776 max 10.778 mean 10.778	1324 ROW-GI AUTEIT	GPU 64 COO min 3.470 max 3.660 mean 3.572
1251	mhd4800a.mtx	man 10.770 max 10.770 mean 10.770	1325	CSR min 3.640 max 4.190 mean 3.809
1252	Regular		1326	H min 10.572 max 10.584 mean 10.580
1252		GPU 64 COO min 4.570 max* 4.710 mean 4.608	1327 Column-Gradient	
			1328	GPU 64 COO min 3,430 max 3,650 mean 3,562
1254 1255		CSR min 12.690 max*13.940 mean 13.369 H min 7.132 max 7.132 mean 7.132	1328 1329	GPU 64 COO min 3.430 max 3.650 mean 3.562 CSR min 3.670 max* 4.290 mean 3.793

1330		H min 10.828 max*10.840 mean 10.834	1404	GPU 64 COO min 4.540 max 4.940 mean 4.874
1331	Row-Column-Permute		1405	CSR min 6.280 max 6.520 mean 6.403
1332		GPU 64 COO min 3.370 max 3.610 mean 3.502	1406	H min 10.042 max 10.047 mean 10.044
1333		CSR min 3.610 max 3.970 mean 3.744	1407 Row-Gradient	
1334		H min 10.738 max 10.741 mean 10.740	1408	GPU 64 COO min 4.830 max 4.930 mean 4.875
	ODE 3754	11 III 10.730 IIIAX 10.741 IIICAN 10.740		
1335	OPF_3754.mtx		1409	CSR min 5.790 max* 6.560 mean 6.289
1336	Regular		1410	H min 9.675 max 9.706 mean 9.692
1337		GPU 64 COO min 4.700 max* 4.930 mean 4.842	1411 Column-Gradient	
1338		CSR min 6.230 max* 6.600 mean 6.411	1412	GPU 64 COO min 4.790 max* 4.960 mean 4.880
1339		H min 8.393 max 8.393 mean 8.393	1413	CSR min 5.760 max 6.450 mean 6.204
1340	Row-Premute		1414	H min 10.601 max*10.661 mean 10.626
1341		GPU 64 COO min 4.620 max 4.890 mean 4.787	1415 Row-Column-Permute	
1342		CSR min 5.780 max 6.310 mean 6.192	1416	GPU 64 COO min 4.330 max 4.950 mean 4.845
1343		H min 11.265 max 11.272 mean 11.269	1417	CSR min 5.740 max 6.500 mean 6.375
1344	Row-Gradient		1418	H min 10.041 max 10.046 mean 10.044
1345		GPU 64 COO min 4.570 max 4.870 mean 4.776	1419 TSOPF_RS_b39_c7.mtx	
1346		CSR min 5.770 max 6.510 mean 6.302	1420 Regular	
1347		H min 10.464 max 10.473 mean 10.468	1421	GPU 64 COO min 4.300 max* 4.430 mean 4.364
1348	Column-Gradient		1422	CSR min 4.480 max 4.750 mean 4.716
1349	COLUMN OF GALLING	GPU 64 COO min 4.580 max 4.870 mean 4.756	1423	H min 7.304 max 7.304 mean 7.304
				11 IIII1 7.304 IIIax 7.304 IIIeaii 7.304
1350		CSR min 5.630 max 6.180 mean 6.055	1424 Row-Premute	
1351		H min 11.394 max*11.401 mean 11.397	1425	GPU 64 COO min 4.260 max 4.400 mean 4.353
1352	Row-Column-Permute		1426	CSR min 4.490 max 4.770 mean 4.734
1353		GPU 64 COO min 4.610 max 4.900 mean 4.780	1427	H min 10.536 max 10.541 mean 10.539
1354		CSR min 5.010 max 6.300 mean 6.113	1428 Row-Gradient	
1355		H min 11.268 max 11.272 mean 11.270	1429	GPU 64 COO min 3.970 max 4.420 mean 4.338
1356	OPF_6000.mtx		1430	CSR min 4.620 max* 4.820 mean 4.789
1357	Regular		1431	H min 9.638 max 9.644 mean 9.641
1358		GPU 64 COO min 3.780 max* 3.920 mean 3.864	1432 Column-Gradient	
1359		CSR min 4.270 max 4.360 mean 4.332	1433	GPU 64 COO min 4.240 max 4.430 mean 4.368
1360		H min 8.799 max 8.799 mean 8.799	1434	CSR min 4.710 max 4.770 mean 4.736
1361	Row-Premute		1435	H min 11.129 max*11.222 mean 11.205
1362		GPU 64 COO min 3.770 max 3.870 mean 3.821	1436 Row-Column-Permute	
1363		CSR min 3.970 max*11.050 mean 4.439	1437	GPU 64 COO min 4.260 max 4.410 mean 4.359
				CSR min 4.660 max 4.760 mean 4.738
1364		H min 11.872 max 11.877 mean 11.875	1438	
1365	Row-Gradient		1439	H min 10.537 max 10.541 mean 10.539
1366		GPU 64 COO min 3.700 max 3.870 mean 3.795		
1367		CSR min 4.330 max 4.440 mean 4.403		
1367 1368		CSR min 4.330 max 4.440 mean 4.403 H min 11.109 max 11.116 mean 11.113	11 FIII	
	Column-Gradient		1440 11 FIJI	
1368 1369	Column-Gradient	H min 11.109 max 11.116 mean 11.113	•	
1368 1369 1370	Column-Gradient	H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_03.mtx	
1368 1369 1370 1371	Column-Gradient	H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804 CSR min 4.260 max 4.340 mean 4.308	1441 mult_dcop_03.mtx 1442 Regular	
1368 1369 1370 1371 1372		H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_03.mtx 1442 Regular 1443	GPU 64 COO min 5.140 max* 5.140 mean 5.140
1368 1369 1370 1371 1372 1373	Column-Gradient Row-Column-Permute	H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804 CSR min 4.260 max 4.340 mean 4.308 H min 12.041 max*12.045 mean 12.043	1441 mult_dcop_03.mtx 1442 Regular	GPU 64 COO min 5.140 max* 5.140 mean 5.140 CSR min 10.340 max*10.390 mean 10.365
1368 1369 1370 1371 1372		H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804 CSR min 4.260 max 4.340 mean 4.308	1441 mult_dcop_03.mtx 1442 Regular 1443	
1368 1369 1370 1371 1372 1373		H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804 CSR min 4.260 max 4.340 mean 4.308 H min 12.041 max*12.045 mean 12.043	1441 mult_dcop_03.mtx 1442 Regular 1443 1444	CSR min 10.340 max*10.390 mean 10.365
1368 1369 1370 1371 1372 1373 1374		H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445	CSR min 10.340 max*10.390 mean 10.365
1368 1369 1370 1371 1372 1373 1374 1375		H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980
1368 1369 1370 1371 1372 1373 1374 1375 1376	Row-Column-Permute	H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377	Row-Column-Permute	H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378	Row-Column-Permute	H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379	Row-Column-Permute	H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.990 mean 5.085
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380	Row-Column-Permute shermanACb.mtx Regular	H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 5.085 CSR min 9.720 max 10.300 mean 10.010
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381	Row-Column-Permute	H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_83.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.990 mean 5.085
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380	Row-Column-Permute shermanACb.mtx Regular	H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 5.085 CSR min 9.720 max 10.300 mean 10.010
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381	Row-Column-Permute shermanACb.mtx Regular	H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_83.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 5.085 CSR min 9.720 max 10.300 mean 10.010
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381 1382	Row-Column-Permute shermanACb.mtx Regular	H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 1454 Column-Gradient	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381 1382 1383 1384	Row-Column-Permute shermanACb.mtx Regular Row-Premute	H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_83.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 1454 Column-Gradient 1455 1456	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 10.010 H min 10.579 max 10.582 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 5.075 CSR min 9.330 max 9.770 mean 9.550
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1389 1380 1381 1382 1383 1384 1385	Row-Column-Permute shermanACb.mtx Regular	H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 1454 Column-Gradient 1455 1456 1457	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 10.800 H min 10.579 max 10.582 mean 10.580 GPU 64 COO min 5.080 max 5.120 mean 5.075
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1380 1381 1382 1383 1384 1385 1386	Row-Column-Permute shermanACb.mtx Regular Row-Premute	H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 1454 Column-Gradient 1455 1456 1457 1458 Row-Column-Permute	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 10.739 GPU 64 COO min 5.080 max 5.990 mean 10.739 GPU 64 COO min 5.080 max 5.990 mean 10.010 H min 10.579 max 10.582 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 5.075 CSR min 9.330 max 9.770 mean 9.550 H min 10.835 max*10.838 mean 10.836
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1380 1381 1382 1383 1384 1385 1386 1387	Row-Column-Permute shermanACb.mtx Regular Row-Premute	H min 11.109 max 11.116 mean 11.113	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 1454 Column-Gradient 1455 1456 1457 1458 Row-Column-Permute	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 10.010 H min 10.579 max 10.582 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 5.075 CSR min 9.330 max 9.770 mean 9.550 H min 10.835 max*10.838 mean 10.836
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381 1382 1383 1384 1385 1386 1387	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient	H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_83.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 Column-Gradient 1455 1456 1457 1458 Row-Column-Permute	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 10.010 H min 10.579 max 10.582 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 9.550 H min 10.835 max*10.838 mean 10.836 GPU 64 COO min 5.000 max 5.010 mean 5.005 CSR min 7.580 max 9.460 mean 5.005
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1380 1381 1381 1382 1383 1384 1385 1386 1387 1388 1388 1388 1388	Row-Column-Permute shermanACb.mtx Regular Row-Premute	H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 1454 Column-Gradient 1455 1456 1457 1458 Row-Column-Permute	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 10.010 H min 10.579 max 10.582 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 5.075 CSR min 9.330 max 9.770 mean 9.550 H min 10.835 max*10.838 mean 10.836
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381 1382 1383 1384 1385 1386 1387 1388 1388 1388 1388 1388 1388 1388	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient	GPU 64 COO min 2.920 max 3.870 mean 3.804	1441 mult_dcop_83.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 Column-Gradient 1455 1456 1457 1458 Row-Column-Permute	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 10.010 H min 10.579 max 10.582 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 9.550 H min 10.835 max*10.838 mean 10.836 GPU 64 COO min 5.000 max 5.010 mean 5.005 CSR min 7.580 max 9.460 mean 5.005
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1380 1381 1381 1382 1383 1384 1385 1386 1387 1388 1388 1388 1388	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient	H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 1454 Column-Gradient 1455 1456 1457 1458 Row-Column-Permute	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 10.010 H min 10.579 max 10.582 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 9.550 H min 10.835 max*10.838 mean 10.836 GPU 64 COO min 5.000 max 5.010 mean 5.005 CSR min 7.580 max 9.460 mean 5.005
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381 1382 1383 1384 1385 1386 1387 1388 1388 1388 1388 1388 1388 1388	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient	GPU 64 COO min 2.920 max 3.870 mean 3.804	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 1454 Column-Gradient 1455 1456 1457 1458 Row-Column-Permute 1459 1460 1461 1462 mult_dcop_03.mtx	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 10.010 H min 10.579 max 10.582 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 10.880 GPU 64 COO min 5.030 max 5.120 mean 9.550 H min 10.835 max*10.838 mean 10.836 GPU 64 COO min 5.000 max 5.010 mean 5.005 CSR min 7.580 max 9.460 mean 8.520
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1380 1381 1381 1384 1385 1384 1385 1387 1388 1389 1391 1391	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient	H min 11.109 max 11.116 mean 11.113	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 Column-Gradient 1455 1456 1457 1458 Row-Column-Permute 1460 1461 1462 mult_dcop_03.mtx 1463 1464	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 10.010 H min 10.579 max 10.300 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 9.550 H min 10.835 max*10.838 mean 10.836 GPU 64 COO min 5.000 max 5.010 mean 5.005 CSR min 9.330 max 9.770 mean 9.550 H min 10.835 max*10.838 mean 10.836 GPU 64 COO min 5.000 max 5.010 mean 5.005 CSR min 7.580 max 9.460 mean 8.520 H min 10.739 max 10.741 mean 10.740
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1380 1381 1382 1383 1384 1385 1386 1389 1390 1391 1391 1392	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient Column-Gradient	H min 11.109 max 11.116 mean 11.113 GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 1454 Column-Gradient 1455 1456 1457 1458 Row-Column-Permute 1460 1461 mult_dcop_03.mtx 1461 1462 mult_dcop_03.mtx 1464 1464	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.990 mean 10.010 H min 10.579 max 10.582 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 5.075 CSR min 9.330 max 9.770 mean 9.550 H min 10.835 max*10.838 mean 10.836 GPU 64 COO min 5.080 max 9.460 mean 8.520 H min 10.739 max 10.741 mean 10.740 GPU 64 COO min 5.140 max* 5.140 mean 5.140 CSR min 10.340 max*10.390 mean 10.365
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1380 1381 1382 1383 1384 1385 1387 1388 1389 1391 1392 1393 1394 1395	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient Column-Gradient	H min 11.109 max 11.116 mean 11.113	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 1454 Column-Gradient 1455 1456 1457 1458 Row-Column-Permute 1460 1461 mult_dcop_03.mtx 1463 Regular 1465 1466	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 10.010 H min 10.579 max 10.582 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 5.075 CSR min 9.330 max 9.770 mean 9.550 H min 10.835 max*10.838 mean 10.836 GPU 64 COO min 5.000 max 5.010 mean 5.005 CSR min 7.580 max 9.460 mean 8.520 H min 10.739 max 10.741 mean 10.740
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381 1382 1383 1384 1385 1386 1387 1391 1392 1393 1394 1395	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient Column-Gradient	H min 11.109 max 11.116 mean 11.113	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 Column-Gradient 1455 1456 1457 Row-Column-Permute 1460 1461 1462 mult_dcop_03.mtx 1464 1465 1466 1467 Row-Premute	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 10.010 H min 10.579 max 10.582 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 5.075 CSR min 9.330 max 9.770 mean 9.550 H min 10.835 max*10.838 mean 10.836 GPU 64 COO min 5.000 max 5.010 mean 5.005 CSR min 7.580 max 9.460 mean 8.520 H min 10.739 max 10.741 mean 10.740 GPU 64 COO min 5.140 max* 5.140 mean 5.140 CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1389 1380 1381 1382 1383 1384 1389 1390 1391 1391 1392 1393 1394 1395 1396 1397	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient Column-Gradient	H min 11.109 max 11.116 mean 11.113	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 1454 Column-Gradient 1455 1456 1457 1458 Row-Column-Permute 1460 1461 1462 mult_dcop_03.mtx 1463 1464 1465 1466 1467 Row-Premute	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 10.010 H min 10.579 max 10.582 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 10.836 H min 10.835 max*10.838 mean 10.836 GPU 64 COO min 5.090 max 5.010 mean 5.005 CSR min 7.580 max 9.760 mean 8.520 H min 10.739 max 10.741 mean 10.740 GPU 64 COO min 5.140 max* 5.140 mean 5.140 CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 5.140 max 4.990 mean 4.980
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1380 1379 1380 1381 1382 1383 1384 1389 1390 1391 1392 1393 1394 1395 1396 1397 1398	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute	H min 11.109 max 11.116 mean 11.113	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 Column-Gradient 1455 1456 1457 Row-Column-Permute 1460 1461 1462 mult_dcop_03.mtx 1464 1465 1466 1467 Row-Premute	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 10.010 H min 10.579 max 10.300 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 5.075 CSR min 9.330 max 9.770 mean 9.550 H min 10.835 max*10.838 mean 10.836 GPU 64 COO min 5.000 max 5.010 mean 5.005 CSR min 7.580 max 9.460 mean 8.520 H min 10.739 max 10.741 mean 10.740 GPU 64 COO min 5.140 max* 5.140 mean 5.140 CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1389 1380 1381 1382 1383 1384 1389 1390 1391 1391 1392 1393 1394 1395 1396 1397	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient Column-Gradient	GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 1454 Column-Gradient 1455 1456 1457 1458 Row-Column-Permute 1460 1461 1462 mult_dcop_03.mtx 1463 1464 1465 1466 1467 Row-Premute	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 10.010 H min 10.579 max 10.582 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 10.836 H min 10.835 max*10.838 mean 10.836 GPU 64 COO min 5.090 max 5.010 mean 5.005 CSR min 7.580 max 9.760 mean 8.520 H min 10.739 max 10.741 mean 10.740 GPU 64 COO min 5.140 max* 5.140 mean 5.140 CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 5.140 max 4.990 mean 4.980
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1380 1379 1380 1381 1382 1383 1384 1389 1390 1391 1392 1393 1394 1395 1396 1397 1398	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute	H min 11.109 max 11.116 mean 11.113	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 1454 Column-Gradient 1455 1456 1457 1458 Row-Column-Permute 1460 1461 mult_dcop_03.mtx 1461 1462 mult_dcop_03.mtx 1464 1465 1466 1467 Row-Premute 1468 1469	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 10.010 H min 10.579 max 10.582 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 5.085 CSR min 9.720 max 9.770 mean 9.550 H min 10.835 max*10.838 mean 10.836 GPU 64 COO min 5.000 max 5.010 mean 5.005 CSR min 7.580 max 9.460 mean 8.520 H min 10.739 max 10.741 mean 10.740 GPU 64 COO min 5.140 max* 5.140 mean 5.140 CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 5.140 max* 5.140 mean 5.140 CSR min 10.340 max* 9.430 mean 9.689
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1380 1381 1382 1383 1384 1385 1389 1391 1392 1393 1391 1392 1393 1391 1392 1393 1394 1395 1396 1397	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute	GPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_@3.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 1454 Column-Gradient 1455 1456 1457 1458 Row-Column-Permute 1459 1460 1461 1462 mult_dcop_@3.mtx 1463 Regular 1464 1465 1466 1467 Row-Premute	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 10.010 H min 10.579 max 10.582 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 5.085 CSR min 9.720 max 9.770 mean 9.550 H min 10.835 max*10.838 mean 10.836 GPU 64 COO min 5.000 max 5.010 mean 5.005 CSR min 7.580 max 9.460 mean 8.520 H min 10.739 max 10.741 mean 10.740 GPU 64 COO min 5.140 max* 5.140 mean 5.140 CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 5.140 max* 5.140 mean 5.140 CSR min 10.340 max* 9.430 mean 9.689
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381 1382 1383 1384 1385 1386 1387 1390 1391 1391 1392 1393 1394 1395 1396 1397 1398	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute	H min 11.109 max 11.116 mean 11.113	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 1454 Column-Gradient 1455 1456 1457 1458 Row-Column-Permute 1460 1461 1462 mult_dcop_03.mtx 1463 Regular 1464 1465 1466 1467 Row-Premute 1468 1469 1470 Row-Gradient 1472	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 10.739 GPU 64 COO min 5.080 max 5.990 mean 10.739 GPU 64 COO min 5.080 max 5.990 mean 10.010 H min 10.579 max 10.582 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 5.075 CSR min 9.330 max 9.770 mean 9.550 H min 10.835 max*10.838 mean 10.836 GPU 64 COO min 5.080 max 5.010 mean 5.005 CSR min 7.580 max 9.460 mean 8.520 H min 10.739 max 10.741 mean 10.740 GPU 64 COO min 5.140 max* 5.140 mean 5.406 CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.990 mean 10.739
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1380 1381 1382 1383 1384 1389 1399 1391 1392 1393 1394 1395 1396 1397 1398 1399 1399 1400 1401 1401	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute	CPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 1454 Column-Gradient 1455 1456 1457 1458 Row-Column-Permute 1460 1461 mult_dcop_03.mtx 1464 Regular 1465 1465 1466 Row-Premute 1468 1469 1470 1471 Row-Gradient 1472 1473	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 10.610 H min 10.579 max 10.582 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 5.085 CSR min 9.720 max 5.120 mean 5.075 CSR min 9.330 max 9.770 mean 9.550 H min 10.835 max*10.838 mean 10.836 GPU 64 COO min 5.090 max 5.010 mean 5.095 CSR min 7.580 max 9.460 mean 8.520 H min 10.739 max 10.741 mean 10.740 GPU 64 COO min 5.140 max* 5.140 mean 5.140 CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 10.739 GPU 64 COO min 5.080 max 5.090 mean 5.085 CSR min 9.420 max 9.430 mean 10.739
1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381 1382 1383 1384 1389 1390 1391 1391 1392 1393 1394 1395 1397 1398 1397 1398	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute	CPU 64 COO min 3.690 max 3.870 mean 3.804	1441 mult_dcop_03.mtx 1442 Regular 1443 1444 1445 1446 Row-Premute 1447 1448 1449 1450 Row-Gradient 1451 1452 1453 1454 Column-Gradient 1455 1456 1457 1458 Row-Column-Permute 1460 1461 1462 mult_dcop_03.mtx 1463 Regular 1464 1465 1466 1467 Row-Premute 1468 1469 1470 Row-Gradient 1472	CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 10.739 GPU 64 COO min 5.080 max 5.990 mean 10.739 GPU 64 COO min 5.080 max 5.990 mean 10.010 H min 10.579 max 10.582 mean 10.580 GPU 64 COO min 5.030 max 5.120 mean 5.075 CSR min 9.330 max 9.770 mean 9.550 H min 10.835 max*10.838 mean 10.836 GPU 64 COO min 5.080 max 5.010 mean 5.005 CSR min 7.580 max 9.460 mean 8.520 H min 10.739 max 10.741 mean 10.740 GPU 64 COO min 5.140 max* 5.140 mean 5.406 CSR min 10.340 max*10.390 mean 10.365 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.980 CSR min 9.420 max 9.430 mean 9.425 H min 10.739 max 10.739 mean 10.739 GPU 64 COO min 5.080 max 5.990 mean 10.739

1475	Column-Gradient		1549	CSR min 6.360 max 7.450 mean 6.711
1476		GPU 64 COO min 5.030 max 5.120 mean 5.075	1550	H min 11.109 max 11.109 mean 11.109
1477		CSR min 9.330 max 9.770 mean 9.550	1551 Row-Premute	
1478		H min 10.835 max*10.838 mean 10.836	1552	GPU 64 COO min 3.950 max* 3.980 mean 3.953
1479	Row-Column-Permute		1553	CSR min 6.330 max 7.400 mean 6.661
1480		GPU 64 COO min 5.000 max 5.010 mean 5.005	1554	H min 11.098 max 11.104 mean 11.101
1481		CSR min 7.580 max 9.460 mean 8.520	1555 Row-Gradient	
1482		H min 10.739 max 10.741 mean 10.740	1556	GPU 64 COO min 3.960 max 3.980 mean 3.961
1483	mult_dcop_03.mtx		1557	CSR min 6.270 max*10.770 mean 7.017
1484	Regular		1558	H min 11.109 max 11.109 mean 11.109
1485		GPU 64 COO min 5.130 max* 5.220 mean 5.142	1559 Column-Gradient	
1486		CSR min 7.250 max* 9.320 mean 7.722	1560	GPU 64 COO min 3.940 max 3.960 mean 3.950
1487		H min 9.689 max 9.689 mean 9.689	1561	CSR min 6.270 max 7.370 mean 6.696
1488	Row-Premute		1562	H min 11.329 max*11.334 mean 11.331
1489	Now 11 callage	GPU 64 COO min 4.980 max 5.030 mean 4.999	1563 Row-Column-Permute	ii
1490		CSR min 6.460 max 8.470 mean 6.950	1564	GPU 64 COO min 3.950 max 3.960 mean 3.952
1491		H min 10.738 max 10.742 mean 10.740	1565	CSR min 6.180 max 7.420 mean 6.641
	D C 11 1	n IIIII 10.738 IIIax 10.742 IIIean 10.740		
1492	Row-Gradient		1566	H min 11.098 max 11.105 mean 11.101
1493		GPU 64 COO min 5.070 max 5.140 mean 5.088	1567 bloweya.mtx	
1494		CSR min 6.780 max 8.700 mean 7.268	1568 Regular	
1495		H min 10.572 max 10.584 mean 10.580	1569	GPU 64 COO min 0.000 max 0.000 mean 0.000
1496	Column-Gradient		1570	CSR min 0.000 max 0.000 mean 0.000
1497		GPU 64 COO min 4.980 max 5.030 mean 5.010	1571	H min 7.205 max 7.205 mean 7.205
1498		CSR min 6.390 max 7.640 mean 6.982	1572 Row-Premute	
1499		H min 10.825 max*10.845 mean 10.836	1573	GPU 64 COO min 4.020 max 4.030 mean 4.023
1500	Row-Column-Permute		1574	CSR min 6.070 max 6.750 mean 6.340
1501		GPU 64 COO min 4.990 max 5.010 mean 4.997	1575	H min 11.025 max 11.031 mean 11.028
1502		CSR min 6.300 max 7.160 mean 6.636	1576 Row-Gradient	
1503		H min 10.738 max 10.743 mean 10.740	1577	GPU 64 COO min 4.090 max* 4.160 mean 4.111
1504	mult_dcop_01.mtx		1578	CSR min 5.980 max* 7.370 mean 6.678
1505	Regular		1579	H min 10.295 max 10.304 mean 10.300
1506		GPU 64 COO min 5.120 max* 5.140 mean 5.134	1580 Column-Gradient	
1507		CSR min 6.990 max* 9.230 mean 7.546	1581	GPU 64 COO min 3.980 max 4.010 mean 3.995
1508		H min 9.689 max 9.689 mean 9.689	1582	CSR min 5.880 max 6.780 mean 6.295
1509	Row-Premute		1583	H min 10.881 max*10.887 mean 10.883
1510		GPU 64 COO min 4.990 max 5.020 mean 5.004	1584 Row-Column-Permute	
1511		CSR min 6.370 max 7.220 mean 6.771	1585	GPU 64 COO min 4.020 max 4.030 mean 4.023
1512		H min 10.738 max 10.743 mean 10.740	1586	CSR min 5.970 max 6.420 mean 6.183
1513	Row-Gradient	11 IIII1 10.736 IIIAX 10.743 IIIEAN 10.740	1587	H min 11.025 max 11.033 mean 11.028
1514	Now-Grautent	GPU 64 COO min 5.060 max 5.100 mean 5.082		11 IIII1 11.025 IIIAX 11.033 IIIEAII 11.020
1515		CSR min 6.730 max 7.720 mean 7.317	1589 Regular	
1516		H min 10.574 max 10.585 mean 10.580	1590	GPU 64 COO min 4.260 max* 4.270 mean 4.261
1517	Column-Gradient		1591	CSR min 6.440 max 7.640 mean 6.863
1518		GPU 64 COO min 4.980 max 5.100 mean 5.012	1592	H min 8.412 max 8.412 mean 8.412
1519		CSR min 6.580 max 7.510 mean 7.054	1593 Row-Premute	
1520		H min 10.828 max*10.842 mean 10.835	1594	GPU 64 COO min 4.200 max 4.200 mean 4.200
1521	Row-Column-Permute		1595	CSR min 6.020 max 7.030 mean 6.418
1522		GPU 64 COO min 4.970 max 5.000 mean 4.986	1596	H min 9.255 max 9.257 mean 9.256
1523		CSR min 6.390 max 7.050 mean 6.677	1597 Row-Gradient	
1524		H min 10.738 max 10.742 mean 10.740	1598	GPU 64 COO min 4.210 max 4.240 mean 4.226
1525	mult_dcop_02.mtx		1599	CSR min 6.070 max*10.050 mean 6.498
1526	Regular		1600	H min 8.607 max 8.678 mean 8.671
1527		GPU 64 COO min 5.120 max 5.140 mean 5.133	1601 Column-Gradient	
1528		CSR min 6.950 max 7.590 mean 7.336	1602	GPU 64 COO min 4.170 max 4.190 mean 4.180
1529		H min 9.689 max 9.689 mean 9.689	1603	CSR min 5.610 max 7.300 mean 5.988
1530	Row-Premute		1604	H min 9.534 max* 9.601 mean 9.585
1531		GPU 64 COO min 4.970 max 4.990 mean 4.984	1605 Row-Column-Permute	
1532		CSR min 6.440 max 7.110 mean 6.719	1606	GPU 64 COO min 4.190 max 4.190 mean 4.190
1533		H min 10.738 max 10.742 mean 10.740	1607	CSR min 6.070 max 7.000 mean 6.386
1534				
1001	Row-Gradient	n min 10.738 max 10.742 mean 10.740		H min 9 255 may 9 257 mean 9 256
1535	Row-Gradient		1608	H min 9.255 max 9.257 mean 9.256
1535 1536	Row-Gradient	GPU 64 COO min 5.070 max* 5.150 mean 5.086	1608 1609 ex19.mtx	H min 9.255 max 9.257 mean 9.256
1536	Row-Gradient	GPU 64 COO min 5.070 max* 5.150 mean 5.086 CSR min 6.650 max* 7.930 mean 7.304	1608 1609 ex19.mtx 1610 Regular	
1536 1537		GPU 64 COO min 5.070 max* 5.150 mean 5.086	1608 1609 ex19.mtx 1610 Regular 1611	GPU 64 COO min 6.140 max* 6.180 mean 6.159
1536 1537 1538	Row-Gradient Column-Gradient	GPU 64 COO min 5.070 max* 5.150 mean 5.086 CSR min 6.650 max* 7.930 mean 7.304 H min 10.574 max 10.587 mean 10.580	1608 1609 ex19.mtx 1610 Regular 1611 1612	GPU 64 COO min 6.140 max* 6.180 mean 6.159 CSR min 12.780 max*14.400 mean 13.328
1536 1537 1538 1539		GPU 64 COO min 5.070 max* 5.150 mean 5.086 CSR min 6.650 max* 7.930 mean 7.304 H min 10.574 max 10.587 mean 10.580 GPU 64 COO min 4.980 max 5.040 mean 5.012	1608 1609 ex19.mtx 1610 Regular 1611 1612	GPU 64 COO min 6.140 max* 6.180 mean 6.159
1536 1537 1538 1539 1540		GPU 64 COO min 5.070 max* 5.150 mean 5.086 CSR min 6.650 max* 7.930 mean 7.304 H min 10.574 max 10.587 mean 10.580 GPU 64 COO min 4.980 max 5.040 mean 5.012 CSR min 6.520 max 7.650 mean 7.139	1608 1609 ex19.mtx 1610 Regular 1611 1612 1613 1614 Row-Premute	GPU 64 COO min 6.140 max* 6.180 mean 6.159 CSR min 12.780 max*14.400 mean 13.328 H min 8.228 max 8.228 mean 8.228
1536 1537 1538 1539 1540 1541	Column-Gradient	GPU 64 COO min 5.070 max* 5.150 mean 5.086 CSR min 6.650 max* 7.930 mean 7.304 H min 10.574 max 10.587 mean 10.580 GPU 64 COO min 4.980 max 5.040 mean 5.012	1608 1609 ex19.mtx 1610 Regular 1611 1612 1613 1614 Row-Premute 1615	GPU 64 COO min 6.140 max* 6.180 mean 6.159 CSR min 12.780 max*14.400 mean 13.328 H min 8.228 max 8.228 mean 8.228 GPU 64 COO min 5.820 max 5.850 mean 5.833
1536 1537 1538 1539 1540 1541 1542		GPU 64 COO min 5.070 max* 5.150 mean 5.086 CSR min 6.650 max* 7.930 mean 7.304 H min 10.574 max 10.587 mean 10.580 GPU 64 COO min 4.980 max 5.040 mean 5.012 CSR min 6.520 max 7.650 mean 7.139 H min 10.829 max*10.846 mean 10.836	1608 1609 ex19.mtx 1610 Regular 1611 1612 1613 1614 Row-Premute 1615 1616	GPU 64 COO min 6.140 max* 6.180 mean 6.159 CSR min 12.780 max*14.400 mean 13.328 H min 8.228 max 8.228 mean 8.228 GPU 64 COO min 5.820 max 5.850 mean 5.833 CSR min 9.870 max 11.070 mean 10.372
1536 1537 1538 1539 1540 1541	Column-Gradient	GPU 64 COO min 5.070 max* 5.150 mean 5.086 CSR min 6.650 max* 7.930 mean 7.304 H min 10.574 max 10.587 mean 10.580 GPU 64 COO min 4.980 max 5.040 mean 5.012 CSR min 6.520 max 7.650 mean 7.139 H min 10.829 max*10.846 mean 10.836	1608 1609 ex19.mtx 1610 Regular 1611 1612 1613 1614 Row-Premute 1615	GPU 64 COO min 6.140 max* 6.180 mean 6.159 CSR min 12.780 max*14.400 mean 13.328 H min 8.228 max 8.228 mean 8.228 GPU 64 COO min 5.820 max 5.850 mean 5.833
1536 1537 1538 1539 1540 1541 1542	Column-Gradient	GPU 64 COO min 5.070 max* 5.150 mean 5.086 CSR min 6.650 max* 7.930 mean 7.304 H min 10.574 max 10.587 mean 10.580 GPU 64 COO min 4.980 max 5.040 mean 5.012 CSR min 6.520 max 7.650 mean 7.139 H min 10.829 max*10.846 mean 10.836	1608 1609 ex19.mtx 1610 Regular 1611 1612 1613 1614 Row-Premute 1615 1616	GPU 64 COO min 6.140 max* 6.180 mean 6.159 CSR min 12.780 max*14.400 mean 13.328 H min 8.228 max 8.228 mean 8.228 GPU 64 COO min 5.820 max 5.850 mean 5.833 CSR min 9.870 max 11.070 mean 10.372
1536 1537 1538 1539 1540 1541 1542	Column-Gradient	GPU 64 COO min 5.070 max* 5.150 mean 5.086 CSR min 6.650 max* 7.930 mean 7.304 H min 10.574 max 10.587 mean 10.580 GPU 64 COO min 4.980 max 5.040 mean 5.012 CSR min 6.520 max 7.650 mean 7.139 H min 10.829 max*10.846 mean 10.836	1608 1609 ex19.mtx 1610 Regular 1611 1612 1613 1614 Row-Premute 1615 1616	GPU 64 COO min 6.140 max* 6.180 mean 6.159 CSR min 12.780 max*14.400 mean 13.328 H min 8.228 max 8.228 mean 8.228 GPU 64 COO min 5.820 max 5.850 mean 5.833 CSR min 9.870 max 11.070 mean 10.372
1536 1537 1538 1539 1540 1541 1542 1543 1544	Column-Gradient	GPU 64 COO min 5.070 max* 5.150 mean 5.086 CSR min 6.650 max* 7.930 mean 7.304 H min 10.574 max 10.587 mean 10.580 GPU 64 COO min 4.980 max 5.040 mean 5.012 CSR min 6.520 max 7.650 mean 7.139 H min 10.829 max*10.846 mean 10.836 GPU 64 COO min 4.970 max 5.050 mean 4.983 CSR min 6.440 max 7.380 mean 6.779	1608 1609 ex19.mtx 1610 Regular 1611 1612 1613 1614 Row-Premute 1615 1616 1617 1618 Row-Gradient	GPU 64 COO min 6.140 max* 6.180 mean 6.159 CSR min 12.780 max*14.400 mean 13.328 H min 8.228 max 8.228 mean 8.228 GPU 64 COO min 5.820 max 5.850 mean 5.833 CSR min 9.870 max 11.070 mean 10.372 H min 11.836 max 11.840 mean 11.838
1536 1537 1538 1539 1540 1541 1542 1543 1544 1545	Column-Gradient Row-Column-Permute	GPU 64 COO min 5.070 max* 5.150 mean 5.086 CSR min 6.650 max* 7.930 mean 7.304 H min 10.574 max 10.587 mean 10.580 GPU 64 COO min 4.980 max 5.040 mean 5.012 CSR min 6.520 max 7.650 mean 7.139 H min 10.829 max*10.846 mean 10.836 GPU 64 COO min 4.970 max 5.050 mean 4.983 CSR min 6.440 max 7.380 mean 6.779	1608 1609 ex19.mtx 1610 Regular 1611 1612 1613 1614 Row-Premute 1615 1616 1617 1618 Row-Gradient 1619	GPU 64 COO min 6.140 max* 6.180 mean 6.159
1536 1537 1538 1539 1540 1541 1542 1543 1544 1545 1546	Column-Gradient Row-Column-Permute lp_fit2d.mtx	GPU 64 COO min 5.070 max* 5.150 mean 5.086 CSR min 6.650 max* 7.930 mean 7.304 H min 10.574 max 10.587 mean 10.580 GPU 64 COO min 4.980 max 5.040 mean 5.012 CSR min 6.520 max 7.650 mean 7.139 H min 10.829 max*10.846 mean 10.836 GPU 64 COO min 4.970 max 5.050 mean 4.983 CSR min 6.440 max 7.380 mean 6.779	1608 1609 ex19.mtx 1610 Regular 1611 1612 1613 1614 Row-Premute 1615 1616 1617 1618 Row-Gradient 1619	GPU 64 COO min 6.140 max* 6.180 mean 6.159

1623		GPU 64 COO min 5.760 max 5.840 mean 5.813	1697	H min 7.380 max 7.380 mean 7.380
1624		CSR min 9.710 max 14.220 mean 10.376	1698 Row-Premute	
1625		H min 11.873 max*11.882 mean 11.878	1699	GPU 64 COO min 4.130 max 4.170 mean 4.134
1626	Row-Column-Permute		1700	CSR min 6.180 max* 9.200 mean 6.796
1627		GPU 64 COO min 5.810 max 5.860 mean 5.838	1701	H min 10.041 max 10.046 mean 10.044
1628		CSR min 9.920 max 10.820 mean 10.240	1702 Row-Gradient	
1629		H min 11.836 max 11.841 mean 11.838	1703	GPU 64 COO min 4.150 max* 4.220 mean 4.163
1630	brainpc2.mtx		1704	CSR min 6.410 max 7.500 mean 6.816
1631	Regular		1705	H min 9.682 max 9.706 mean 9.693
1632		GPU 64 COO min 0.000 max 0.000 mean 0.000	1706 Column-Gradient	
1633		CSR min 0.000 max 0.000 mean 0.000	1707	GPU 64 COO min 4.080 max 4.110 mean 4.096
1634		H min 7.478 max 7.478 mean 7.478	1708	CSR min 6.020 max 7.220 mean 6.309
1635	Row-Premute		1709	H min 10.597 max*10.658 mean 10.631
1636		GPU 64 COO min 4.760 max 4.790 mean 4.773	1710 Row-Column-Permute	
1637		CSR min 6.930 max 7.780 mean 7.310	1711	GPU 64 COO min 4.120 max 4.140 mean 4.130
1638		H min 9.810 max 9.813 mean 9.811	1712	CSR min 6.210 max 7.200 mean 6.609
1639	Row-Gradient		1713	H min 10.041 max 10.046 mean 10.044
1640		GPU 64 COO min 4.820 max* 4.840 mean 4.831	1714 TSOPF_FS_b9_c6.mtx	
1641		CSR min 7.220 max 8.290 mean 7.583	1715 Regular	
1642		H min 9.721 max 9.725 mean 9.723	1716	GPU 64 COO min 0.000 max 0.000 mean 0.000
1643	Column-Gradient		1717	CSR min 0.000 max 0.000 mean 0.000
1644		GPU 64 COO min 4.760 max 4.820 mean 4.779	1718	H min 7.380 max 7.380 mean 7.380
1645		CSR min 6.870 max* 8.300 mean 7.393	1719 Row-Premute	
1646		H min 10.368 max*10.373 mean 10.370	1720	GPU 64 COO min 4.120 max 4.140 mean 4.129
1647	Row-Column-Permute		1721	CSR min 6.170 max 7.160 mean 6.664
1648		GPU 64 COO min 4.750 max 4.780 mean 4.765	1722	H min 10.041 max 10.045 mean 10.043
1649		CSR min 6.940 max 7.580 mean 7.298	1723 Row-Gradient	
1650		H min 9.809 max 9.814 mean 9.811	1724	GPU 64 COO min 4.150 max* 4.180 mean 4.162
1651	shermanACb.mtx		1725	CSR min 6.420 max 7.360 mean 6.723
1652	Regular		1726	H min 9.682 max 9.706 mean 9.693
1653		GPU 64 COO min 4.090 max* 4.130 mean 4.112	1727 Column-Gradient	
1654		CSR min 6.320 max* 7.200 mean 6.779	1728	GPU 64 COO min 4.080 max 4.120 mean 4.096
1655		H min 8.600 max 8.600 mean 8.600	1729	CSR min 5.880 max 7.090 mean 6.403
1656	Row-Premute		1730	H min 10.611 max*10.660 mean 10.637
1657		GPU 64 COO min 4.020 max 4.050 mean 4.036	1731 Row-Column-Permute	
1658		CSR min 5.670 max 6.460 mean 6.014	1732	GPU 64 COO min 4.130 max 4.140 mean 4.130
1659	David Constitution	H min 10.376 max 10.382 mean 10.379	1733	CSR min 6.330 max* 7.390 mean 6.695
1660	Row-Gradient	CDU 64 000 min 4 050 min 4 100 min 4 074	1734	H min 10.042 max 10.047 mean 10.044
1661		GPU 64 COO min 4.050 max 4.100 mean 4.074	1735 OPF_6000.mtx	
1662		CSR min 5.580 max 6.420 mean 5.996	1736 Regular	CDU 64 000 -/- 7 270 7 270 7 202
1663	0.1	H min 9.918 max 9.924 mean 9.921	1737	GPU 64 COO min 7.270 max* 7.370 mean 7.293
1664	Column-Gradient	CDU C4 C00 4 010 4 000 4 000	1738	CSR min 12.890 max*14.500 mean 13.566
1665		GPU 64 COO min 4.010 max 4.080 mean 4.033 CSR min 0.000 max 6.320 mean 5.527	1739 1740 Row-Premute	H min 8.799 max 8.799 mean 8.799
1666 1667		H min 10.543 max*10.595 mean 10.589	1740 ROW-PT ellid Le	GPU 64 COO min 6.640 max 6.720 mean 6.678
1668	Row-Column-Permute	11 IIII 10.343 IIIAX^10.353 IIIEAII 10.365	1742	CSR min 9.680 max 11.600 mean 10.040
1669	NOW-COTUMIN-FEI MULE	GPU 64 COO min 4.020 max 4.050 mean 4.036	1742	H min 11.873 max 11.877 mean 11.875
1670		CSR min 5.670 max 6.510 mean 6.092	1744 Row-Gradient	11 IIII 11.073 IIIAX 11.077 IIIEAN 11.073
1671		H min 10.377 max 10.381 mean 10.379	1745	GPU 64 COO min 7.090 max 7.140 mean 7.122
1672	cvxqp3.mtx		1746	CSR min 11.250 max 13.030 mean 12.142
1673	Regular		1747	H min 11.110 max 11.117 mean 11.114
1674		GPU 64 COO min 3.500 max* 3.540 mean 3.501	1748 Column-Gradient	
1675		CSR min 11.860 max*13.100 mean 12.694	1749	GPU 64 COO min 6.590 max 6.710 mean 6.644
1676		H min 8.646 max 8.646 mean 8.646	1750	CSR min 9.400 max 13.140 mean 9.991
1677	Row-Premute		1751	H min 12.040 max*12.046 mean 12.043
1678		GPU 64 COO min 3.360 max 3.370 mean 3.365	1752 Row-Column-Permute	
1679		CSR min 6.210 max 7.610 mean 6.631	1753	GPU 64 COO min 6.640 max 6.710 mean 6.679
1680		H min 11.027 max 11.032 mean 11.030	1754	CSR min 9.690 max 10.740 mean 10.050
1681	Row-Gradient		1755	H min 11.874 max 11.877 mean 11.875
1682		GPU 64 COO min 3.370 max 3.380 mean 3.376	1756 OPF_3754.mtx	
1683		CSR min 6.170 max 7.070 mean 6.499	1757 Regular	
1684		H min 11.059 max 11.068 mean 11.064	1758	GPU 64 COO min 4.430 max* 4.450 mean 4.443
1685	Column-Gradient		1759	CSR min 9.710 max*13.000 mean 11.377
1686		GPU 64 COO min 3.350 max 3.390 mean 3.371	1760	H min 8.393 max 8.393 mean 8.393
1687		CSR min 6.150 max 7.180 mean 6.531	1761 Row-Premute	
1688		H min 11.125 max*11.133 mean 11.130	1762	GPU 64 COO min 4.230 max 4.250 mean 4.240
1689	Row-Column-Permute		1763	CSR min 7.430 max 8.750 mean 7.986
1690		GPU 64 COO min 3.350 max 3.380 mean 3.364	1764	H min 11.266 max 11.272 mean 11.269
1691		CSR min 6.040 max 7.440 mean 6.603	1765 Row-Gradient	
1692		H min 11.028 max 11.033 mean 11.030	1766	GPU 64 COO min 4.370 max 4.420 mean 4.382
			47.67	
1693	case9.mtx		1767	CSR min 8.160 max 9.470 mean 8.682
	case9.mtx Regular		1768	CSR min 8.160 max 9.470 mean 8.682 H min 10.462 max 10.473 mean 10.468
1693		GPU 64 COO min 0.000 max 0.000 mean 0.000		H min 10.462 max 10.473 mean 10.468
1693 1694		GPU 64 COO min 0.000 max 0.000 mean 0.000 CSR min 0.000 max 0.000 mean 0.000	1768	

1771		CSR min 7.160 max 8.080 mean 7.595	1845 Day December	
1771 1772		H min 11.394 max*11.401 mean 11.398	1845 Row-Premute 1846	GPU 64 COO min 10.340 max 10.430 mean 10.362
1773	Row-Column-Permute	11 IIII 11.354 IIIAX^11.401 IIIEAII 11.356	1847	CSR min 12.880 max 13.340 mean 13.057
1774	KOW-COIUIIII-FEI IIIULE	GPU 64 COO min 4.230 max 4.250 mean 4.243	1848	H min 10.777 max 10.778 mean 10.777
1775		CSR min 7.230 max 8.940 mean 8.056	1849 Row-Gradient	II IIII 10.777 IIIAX 10.776 IIIEAII 10.777
1776		H min 11.264 max 11.271 mean 11.269	1850	GPU 64 COO min 10.650 max*10.740 mean 10.688
1777	c-47.mtx	11 IIII1 11.204 IIIAX 11.271 IIIEAII 11.209	1851	CSR min 12.310 max 13.670 mean 12.562
1778	Regular		1852	H min 11.247 max 11.300 mean 11.281
1779	Kegutai	GPU 64 COO min 5.320 max* 5.340 mean 5.329	1853 Column-Gradient	11 IIII 11.247 IIIAX 11.300 IIICAN 11.201
1780		CSR min 8.890 max* 9.590 mean 9.249	1854	GPU 64 COO min 10.340 max 10.440 mean 10.398
1781		H min 8.364 max 8.364 mean 8.364	1855	CSR min 9.480 max 10.110 mean 9.782
1782	Row-Premute	11 IIII1 0.304 IIIAX 0.304 IIIEAII 0.304	1856	H min 12.023 max*12.069 mean 12.047
1783	NOW-F1 elliu Le	GPU 64 COO min 5.240 max 5.250 mean 5.241	1857 Row-Column-Permute	11 III11 12.023 IIIAX^12.005 IIIEAI1 12.047
1784		CSR min 7.790 max 8.890 mean 8.214	1858	GPU 64 COO min 10.330 max 10.380 mean 10.356
1785		H min 10.059 max 10.063 mean 10.061	1859	CSR min 12.840 max 13.530 mean 13.119
1786	Row-Gradient	II IIIII 10.035 IIIAX 10.003 IIIEAII 10.001	1860	H min 10.776 max 10.778 mean 10.777
1787	NOW-GI AUTEIIL	GPU 64 COO min 5.230 max 5.260 mean 5.242	1861 aft01.mtx	11 IIII 10.770 IIIAX 10.778 IIIEAN 10.777
1788		CSR min 7.080 max 8.050 mean 7.673	1862 Regular	
1789		H min 10.206 max 10.226 mean 10.218	1863	GPU 64 COO min 3.680 max* 3.690 mean 3.688
1790	Column-Gradient	11 IIII11 10.200 IIIAX 10.220 IIIEAII 10.216	1864	CSR min 13.860 max*14.830 mean 14.560
1791	COTUMNI-OF AUTERIC	GPU 64 COO min 5.080 max 5.120 mean 5.105	1865	H min 7.811 max 7.811 mean 7.811
1792		CSR min 5.780 max 6.970 mean 6.359	1866 Row-Premute	II IIIII 7.011 IIIAX 7.011 IIIEAII 7.011
1793		H min 11.205 max*11.233 mean 11.222	1867	GPU 64 COO min 3.510 max 3.530 mean 3.513
1794	Row-Column-Permute	11 11.203 max*11.233 mean 11.222	1868	CSR min 6.420 max 10.520 mean 7.265
1795	Now Column Termate	GPU 64 COO min 5.220 max 5.250 mean 5.227	1869	H min 11.161 max*11.170 mean 11.165
1796		CSR min 7.860 max 8.710 mean 8.247	1870 Row-Gradient	III III III III III III III III III II
1797		H min 10.059 max 10.064 mean 10.061	1871	GPU 64 COO min 3.630 max 3.670 mean 3.643
1798	mhd4800a.mtx	11 IIII 10.035 IIIAX 10.004 IIIEAII 10.001	1872	CSR min 10.760 max 13.510 mean 12.199
1799	Regular		1873	H min 10.248 max 10.265 mean 10.258
1800	кедитан	GPU 64 COO min 3.090 max* 3.100 mean 3.098	1874 Column-Gradient	11 IIII1 10.246 IIIAX 10.205 IIIEAII 10.236
1801		CSR min 11.570 max*12.290 mean 12.092	1875	GPU 64 COO min 3.510 max 3.520 mean 3.519
1802		H min 7.132 max 7.132 mean 7.132	1876	CSR min 6.490 max 11.230 mean 7.645
1803	Row-Premute	11 IIII1 7.132 IIIAX 7.132 IIIEAII 7.132	1877	H min 11.112 max 11.121 mean 11.117
1804	Now I I clided	GPU 64 COO min 3.020 max 3.020 mean 3.020	1878 Row-Column-Permute	II IIII II II III III. III III III I
1805		CSR min 5.560 max 7.270 mean 6.007	1879	GPU 64 COO min 3.510 max 3.540 mean 3.515
1806		H min 10.959 max*10.968 mean 10.963	1880	CSR min 6.510 max 11.650 mean 7.311
1807	Row-Gradient	11 IIII 10.555 IIIAX*10.500 IIIEAII 10.505	1881	H min 11.161 max 11.168 mean 11.165
1808	NOW OF BUTCHE	GPU 64 COO min 3.080 max 3.100 mean 3.088	1882 TSOPF_RS_b39_c7.mtx	II IIII II. IOI IIIAX II. IOO IIICAN III. IOS
1809		CSR min 10.250 max 12.150 mean 11.340	1883 Regular	
1810		H min 9.509 max 9.528 mean 9.520	1884	GPU 64 COO min 5.970 max* 6.010 mean 5.988
1811	Column-Gradient	11 1111 5.305 max 5.326 mean 5.326	1885	CSR min 12.470 max*21.120 mean 13.816
1812	COTUMNI-OF AUTERIC	GPU 64 COO min 3.020 max 3.050 mean 3.026	1886	H min 7.304 max 7.304 mean 7.304
1813		CSR min 5.530 max 10.580 mean 6.432	1887 Row-Premute	11 IIII1 7.304 IIIAX 7.304 IIIEAII 7.304
1814		H min 10.933 max 10.946 mean 10.939	1888	GPU 64 COO min 5.840 max 5.870 mean 5.856
1815	Row-Column-Permute	11 IIII 10.555 IIIAX 10.546 IIICAN 10.555	1889	CSR min 10.780 max 15.810 mean 11.425
1816	KOW-COIUIIII-FEI IIIULE	GPU 64 COO min 3.020 max 3.020 mean 3.020	1890	H min 10.537 max 10.540 mean 10.539
1817		CSR min 5.510 max 6.830 mean 6.136	1891 Row-Gradient	11 IIII 10.557 IIIAX 10.540 IIICAN 10.555
1818		H min 10.959 max 10.967 mean 10.963	1892	GPU 64 COO min 5.950 max 6.000 mean 5.975
1819	gen4.mtx		1893	CSR min 11.520 max 17.250 mean 12.799
1820	Regular		1894	H min 9.638 max 9.646 mean 9.641
1821	Negazar	GPU 64 COO min 3.300 max* 3.320 mean 3.308	1895 Column-Gradient	
1822		CSR min 5.250 max 6.340 mean 5.705	1896	GPU 64 COO min 5.790 max 5.860 mean 5.827
1823		H min 9.234 max 9.234 mean 9.234	1897	CSR min 10.500 max 14.080 mean 11.237
1824	Row-Premute		1898	H min 11.128 max*11.223 mean 11.209
1825		GPU 64 COO min 3.290 max 3.310 mean 3.299	1899 Row-Column-Permute	
1826		CSR min 5.190 max 7.420 mean 5.683	1900	GPU 64 COO min 5.850 max 5.870 mean 5.855
1827		H min 10.249 max 10.254 mean 10.252	1901	CSR min 10.790 max 15.250 mean 11.718
1828	Row-Gradient		1902	H min 10.537 max 10.541 mean 10.539
1829		GPU 64 COO min 3.300 max 3.310 mean 3.301	1903 mult_dcop_03.mtx	
1830		CSR min 5.370 max 6.310 mean 5.659	1904 Regular	
1831		H min 9.934 max 9.958 mean 9.948	1905	GPU 64 COO min 5.130 max* 5.220 mean 5.142
1832	Column-Gradient	5.550 mcan 5.540	1906	CSR min 7.250 max* 9.320 mean 7.722
1833		GPU 64 COO min 3.240 max 3.260 mean 3.249	1907	H min 9.689 max 9.689 mean 9.689
1834		CSR min 5.090 max* 8.660 mean 5.546	1908 Row-Premute	
1835		H min 10.853 max*10.873 mean 10.864	1909	GPU 64 COO min 4.980 max 5.030 mean 4.999
1836	Row-Column-Permute		1910	CSR min 6.460 max 8.470 mean 6.950
		GPU 64 COO min 3.290 max 3.320 mean 3.296	1911	H min 10.738 max 10.742 mean 10.740
1837			1912 Row-Gradient	10.740
1837				
		CSR min 5.190 max 7.550 mean 5.659 H min 10.249 max 10.255 mean 10.252	1913	GPU 64 COO min 5.0/0 max 5.140 mean 5 0xx
1837 1838 1839	Maragal 6.mtx		1913 1914	GPU 64 COO min 5.070 max 5.140 mean 5.088 CSR min 6.780 max 8.700 mean 7.268
1837 1838 1839 1840	Maragal_6.mtx Regular		1914	CSR min 6.780 max 8.700 mean 7.268
1837 1838 1839 1840 1841	Maragal_6.mtx Regular	H min 10.249 max 10.255 mean 10.252	1914 1915	CSR min 6.780 max 8.700 mean 7.268
1837 1838 1839 1840			1914 1915 1916 Column-Gradient	CSR min 6.780 max 8.700 mean 7.268 H min 10.572 max 10.584 mean 10.580
1837 1838 1839 1840 1841 1842		H min 10.249 max 10.255 mean 10.252 GPU 64 COO min 10.580 max 10.620 mean 10.599	1914 1915	CSR min 6.780 max 8.700 mean 7.268

1919		Н		min	10.825	max	*10.845	mean	10.836	1974
1920	Row-Column-Permute									1975
1921		GPU 6	54 COO	min	4.990	max	5.010	mean	4.997	
1922			CSR	min	6.300	max	7.160	mean	6.636	1976
1923		Н		min	10.738	max	10.743	mean	10.740	1977
										1070

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