Entropy Maximization in Sparse Matrix by Vector Multiplication

ABHISHEK JAIN, ISMAIL BUSTANY, and PAOLO D'ALBERTO

The peak performance of any SpMV accelerator depends primarily on the available DRAM memory bandwidth 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. GPUs along with some DSA ASIC's and new FPGA architectures exhibit very high bandwidth: utilizing this much bandwidth efficiently is difficult for large scale and highly sparse matrices due to very high random access pattern and workload imbalance. We propose a matrix permutation pre-processing step that aims to maximize the entropy of the distribution of the nonzero elements. We conjecture this would be most effective for matrices with no dense rows or columns, as preconditioning, thus justified when the matrix is reused. Unlike matrix ordering schemes that seek to reduce fill, we seek a 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 shall show that randomization is an optimization that any architecture 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.

3 ACM Reference Format:

Abhishek Jain, Ismail Bustany, and Paolo D'Alberto. 2020. Entropy Maximization in Sparse Matrix by Vector Multiplication . 1, 1 (July 2020), 27 pages.

1 INTRODUCTION

20

21

23

24

25

27

30

To define the scope of this work, the obvious questions to ask are: first, what is randomization (or entropy maximization) in the context of sparse matrices; second, why would we use it; third, when does it work. We shall provide formal definitions in the following sections. Specifically, we will randomly permute 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 restricted 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.

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

Authors' address: Abhishek Jain; Ismail Bustany; Paolo D'Alberto.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than ACM must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from permissions@acm.org.

© 2020 Association for Computing Machinery.

Manuscript submitted to ACM

communication [3, 4]. 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 MISSING CITATION [] . Most of the existing accelerators saturate the relatively low memory bandwidth available on FPGA platforms (less than 80 GB/s) MISSING CITATION [] . 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. 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 MISSING CITATION []. 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 MISSING CITATION [] . 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. During execution, multiple column indices are used as addresses to read corresponding vector entries; we shall provide more details 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 (ie. 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 is 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.

65

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 impact the HW-SW solution.

Manuscript submitted to ACM

Row or column shuffling is already used by custom hardware to re-organize the data flow to reduce communications and computational bottlenecks. We will study various forms of random permutations and their impact on performance if at all.

For the readers in the field of algorithms, SpMV can be mapped into a sorting algorithm. Bare with us, Sorting is a method to find if an element is in a list with no prior or limited knowledge of its contents. Sorting is 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. Interestingly, the best sorting algorithm is a function of the distribution of elements. In a sense, If one is stuck with a sorting algorithm and a poor distribution, randomization may alter the distribution and throttle performance,

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 task 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

76

81

84

85

91

93

94

95

100

101

102

104

105

106

107

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 $\mathbb{M}\mathbf{x}$ is $O(M+N) \approx 2nnz$. 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 canbe 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. While taccess of the (dense) vector \mathbf{x} has no particular pattern.

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. 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 (OR ENTROPY MAXIMIZATION)

We define Randomization as row or column permutation transform of the matrix \mathbb{M} (thus a permutation of y and x), and we choose these by a pseudo-random process. The obvious question to as is why should we seek randomization (or entropy maximizing) 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. Well, it is. 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). This is the culminating point of knowing, and we must strive to it. 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 x we could exploit column load balancing and exploit better sorting algorithms: In practice, the reading of $x_{COL[i]}$ can be reduced to a sorting, and there we know that different sparsity may require different algorithms. This may be 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.

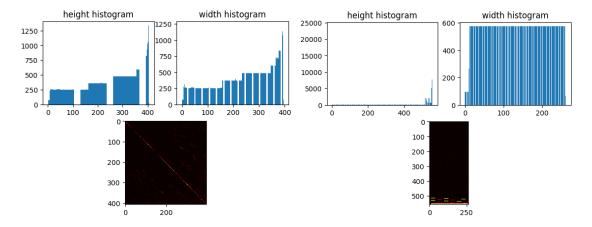


Fig. 1. Left: OPF 3754. Right: LP OSA 07. These are histograms where we represent normalized buckets and counts

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. There is no conceptual difference when the PDF represents a two dimensional distribution. Thus 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 only their probabilities. By construction, the matrices are quite different in sparsity and in shapes, however their entropy numbers are very 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 (which is a symmetric measure, please do not use Kullback-Leibler KL divergence) [2]. Or we could 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 a hierarchical entropy heat maps.

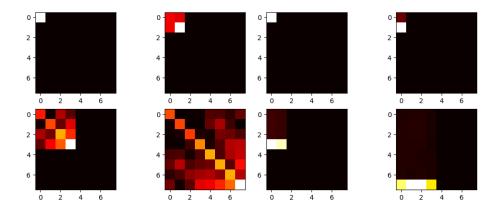


Fig. 2. Hierarchical 2D entropy for OPF 3754 (left) and LP OSA 07 (right).

We can see that a granular entropy summarizes better the nature of the matrix because it keep some spatial information. In this work, the entropy vector is used mostly for visualization purpose more than for comparison purpose. 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.

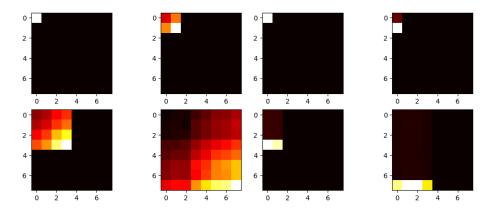


Fig. 3. Hierarchical 2D entropy after row and column random permutation for OPF 3754 (left) and LP OSA 07 (right).

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) but it is reasonable a slightly modified version of the original is still a random selection but unfortunately they seem more likely than they should. We need to compensate or help the randomization so that this current implementation does not get too lazy.

Manuscript submitted to ACM

170

171

172

173

174

177

179

180

181

182

183

184

185

186

187

189

190

191

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

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

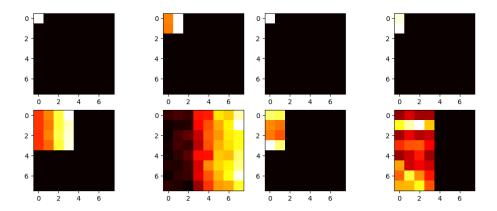


Fig. 4. Hierarchical 2D entropy after height gradient based shuffle and row random permutation for OPF 3754 (left) and LP OSA 07 (right).

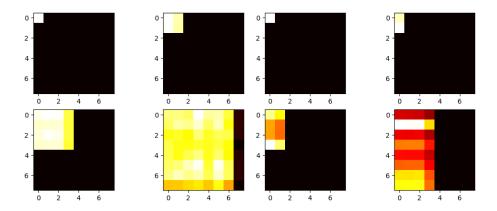


Fig. 5. Hierarchical 2D entropy after height and width gradient shuffle and row and column random permutation for OPF 3754 (left) and LP OSA 07 (right).

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

194

196

197

198

201

202

203

204

206

207

208

209

214

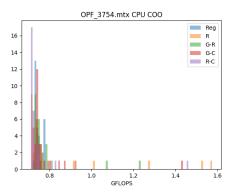
Whether or not this ever applied to the reader, when we have timed algorithms (i.e., measure execution time), we came to expect variation. The introduction of randomization may hide behind the ever present variance, after all these are algorithms on *small* inputs and small error can be comparable to 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 matrix without any permutation and thus is the regular; **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 CPU performance using COO and CSR SpMV algorithms for the matrix OPF 3754. We can see that the CSR algorithms are consistent and the Regular (i.e., the original) has always the best performance. For the COO, permutations introduce long tails, thus performance advantage.



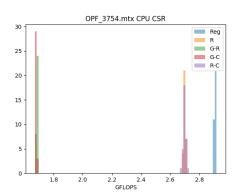
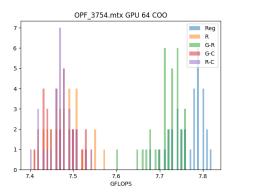


Fig. 6. CPU COO (left) and CPU CSR (left) for OPF 3754

In Figure 7, 8 and 9, 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.



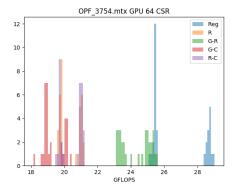
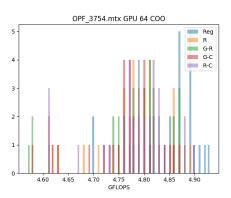


Fig. 7. Vega 20, GPU 64bits COO (left) and GPU CSR (right) for OPF 3754



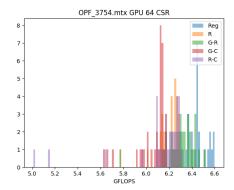
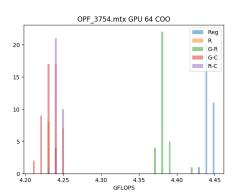


Fig. 8. Ellesmere, GPU 64bits COO (left) and GPU CSR (right) for OPF 3754



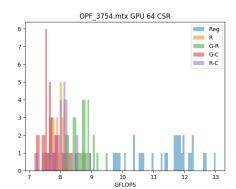


Fig. 9. Fiji, GPU 64bits COO (left) and GPU CSR (right) for OPF 3754

If we take the original matrix and split into part having the same number of rows, and execute them in parallel using different cores, we can see in Figure 10 that randomization is quite useful.

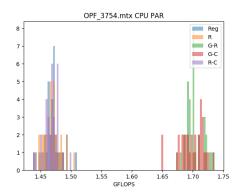


Fig. 10. Parallel CPU CSR for OPF 3754

219 220

221

222

223

224

225

226

227

228

229

230

231

For matrix LP OSA 07, randomization helps clearly only for CPU CSR as we show in Figure 11

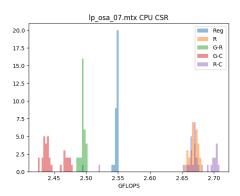
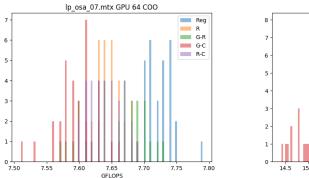


Fig. 11. CPU CSR for LP OSA 07

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).

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.

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.



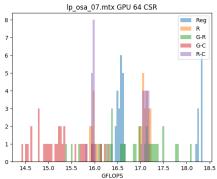
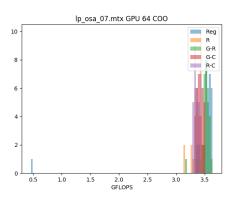


Fig. 12. Vega 20, GPU 64bits COO (left) and GPU CSR (right) for OPF 3754



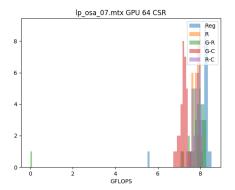
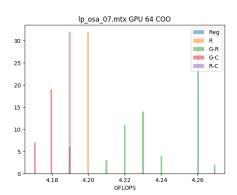


Fig. 13. Ellesmere, GPU 64bits COO (left) and GPU CSR (right) for OPF 3754



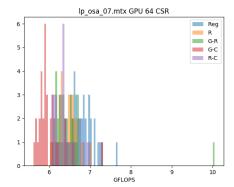


Fig. 14. Fiji, GPU 64bits COO (left) and GPU CSR (right) for OPF 3754

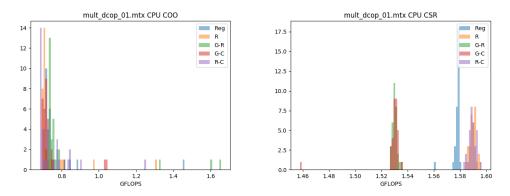


Fig. 15. CPU COO (left) and CPU CSR (right) for MULT DCOP 01

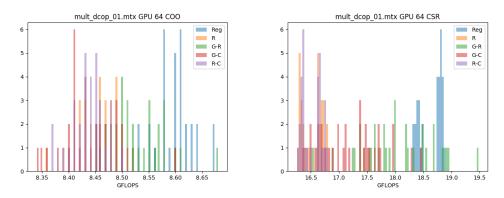


Fig. 16. Vega 20, GPU 64bits COO (left) and GPU CSR (right) for MULT DCOP 01

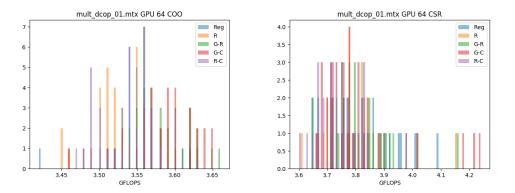
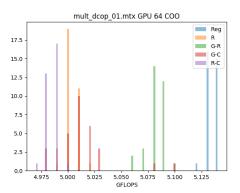


Fig. 17. Ellesmere, GPU 64bits COO (left) and GPU CSR (right) for MULT DCOP 01



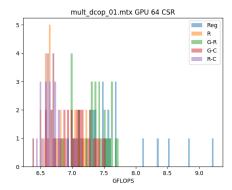


Fig. 18. Fiji, GPU 64bits COO (left) and GPU CSR (right) for MULT DCOP 01

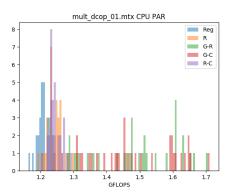


Fig. 19. Parallel CPU CSR for MULT DCOP 01

7 WORKLOADS

233

234

235

236

237

238

239

240

241

243

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.

7.1 Python COO and CSR algorithms

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

246

249

251

255

259

261

264

265

271

273

274

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 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

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.

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 Manuscript submitted to ACM

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:

284

286

287

288

289

290

291

292

293

294

- 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 area 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 redistribute every other sample/card to different parts and these can be permuted locally.

We report in the following the performance results, 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.

297	9 VEGA VII A	AND THREADRIPPER	370	mult_dcop_02.mtx	
200			371	Regular	
298	mult_dcop_03.mtx		372		CPU COO min 1.615 max* 1.677 mean 1.652
299 300	Regular	CPU COO min 0.728 max 0.880 mean 0.757	373		CPU CSR min 1.539 max 1.579 mean 1.575
301		CPU CSR min 1.563 max 1.581 mean 1.577	374		GPU 64 COO min 8.530 max* 8.700 mean 8.614
302		GPU 64 COO min 8.540 max* 8.670 mean 8.619	375		CSR min 18.290 max 18.890 mean 18.597
303		CSR min 18.320 max 18.930 mean 18.620	376		CPU PAR min 1.120 max 1.248 mean 1.211
304		CPU PAR min 1.170 max 1.269 mean 1.226	377		H min 9.689 max 9.689 mean 9.689
305		H min 9.689 max 9.689 mean 9.689	378	Row-Premute	
306	Row-Premute	11 1111 3.003 max 3.003 mean 3.003	379		CPU COO min 0.684 max 0.780 mean 0.705
307		CPU COO min 0.710 max 0.845 mean 0.724	380		CPU CSR min 1.558 max* 1.596 mean 1.588
308		CPU CSR min 1.549 max* 1.597 mean 1.589	381		GPU 64 COO min 8.360 max 8.490 mean 8.433
309		GPU 64 COO min 8.360 max 8.540 mean 8.442	382		CSR min 16.240 max 16.750 mean 16.552
310		CSR min 16.260 max 16.780 mean 16.551	383		CPU PAR min 1.182 max 1.277 mean 1.242
311		CPU PAR min 1.205 max 1.319 mean 1.263	384		H min 10.737 max 10.742 mean 10.740
312		H min 10.737 max 10.742 mean 10.740	385	Row-Gradient	
313	Row-Gradient		386		CPU COO min 0.704 max 1.373 mean 0.790
314		CPU COO min 0.706 max 1.603 mean 0.806	387		CPU CSR min 1.518 max 1.535 mean 1.529
315		CPU CSR min 1.493 max 1.534 mean 1.528	388		GPU 64 COO min 8.420 max 8.590 mean 8.517
316		GPU 64 COO min 8.430 max 8.610 mean 8.527	389		CSR min 16.680 max*19.550 mean 17.907
317		CSR min 17.070 max*18.970 mean 18.115	390 391		CPU PAR min 1.328 max* 1.713 mean 1.484 H min 10.572 max 10.585 mean 10.581
318		CPU PAR min 1.331 max 1.695 mean 1.513	392	Column-Gradient	11 III.11 10.372 III.3X 10.363 III.Edii 10.361
319		H min 10.576 max 10.585 mean 10.580	393	COTUMIN-OF AUTERIC	CPU COO min 0.697 max 1.460 mean 0.742
320	Column-Gradient		394		CPU CSR min 1.517 max 1.534 mean 1.527
321		CPU COO min 0.694 max* 1.632 mean 0.797	395		GPU 64 COO min 8.330 max 8.490 mean 8.420
322		CPU CSR min 1.491 max 1.534 mean 1.529	396		CSR min 16.020 max 18.390 mean 17.303
323		GPU 64 COO min 8.350 max 8.520 mean 8.429	397		CPU PAR min 1.321 max 1.709 mean 1.557
324		CSR min 15.970 max 18.180 mean 17.124	398		H min 10.823 max*10.843 mean 10.835
325		CPU PAR min 1.321 max* 1.728 mean 1.514	399	Row-Column-Permute	
326		H min 10.826 max*10.840 mean 10.833	400		CPU COO min 0.691 max 0.746 mean 0.698
327	Row-Column-Permute		401		CPU CSR min 1.568 max 1.595 mean 1.587
328		CPU COO min 0.688 max 0.757 mean 0.696	402		GPU 64 COO min 8.350 max 8.500 mean 8.436
329		CPU CSR min 1.490 max 1.595 mean 1.584	403		CSR min 16.250 max 16.780 mean 16.517
330		GPU 64 COO min 8.380 max 8.500 mean 8.445 CSR min 16.230 max 16.780 mean 16.513	404		CPU PAR min 1.187 max 1.280 mean 1.228
331 332		CSR min 16.230 max 16.780 mean 16.513 CPU PAR min 1.192 max 1.274 mean 1.237	405		H min 10.739 max 10.743 mean 10.740
333		H min 10.737 max 10.742 mean 10.740	406	lp_fit2d.mtx	
334	mult_dcop_01.mtx	11 IIII1 10.737 IIIAX 10.742 IIIEAN 10.740	407	Regular	
335	Regular		408		CPU COO min 0.774 max 0.804 mean 0.793
336	Negazar	CPU COO min 0.710 max 1.453 mean 0.761	409		CPU CSR min 2.538 max 2.550 mean 2.547
337		CPU CSR min 1.561 max 1.581 mean 1.578	410		GPU 64 COO min 7.060 max 7.170 mean 7.101
338		GPU 64 COO min 8.520 max 8.670 mean 8.597	411		CSR min 15.650 max*18.700 mean 18.031
339		CSR min 18.320 max 18.870 mean 18.636	412		CPU PAR min 1.537 max 1.645 mean 1.590
340		CPU PAR min 1.163 max 1.246 mean 1.212	413		H min 11.109 max 11.109 mean 11.109
341		H min 9.689 max 9.689 mean 9.689	414	Row-Premute	
342	Row-Premute		415		CPU COO min 0.740 max 0.776 mean 0.746
343		CPU COO min 0.699 max 1.305 mean 0.745	416		CPU CSR min 3.302 max* 3.328 mean 3.317
344		CPU CSR min 1.585 max 1.597 mean 1.590	417 418		GPU 64 COO min 7.040 max* 7.180 mean 7.098 CSR min 15.690 max 18.580 mean 16.732
345		GPU 64 COO min 8.360 max 8.520 mean 8.446	419		CPU PAR min 1.327 max 1.482 mean 1.422
346		CSR min 16.260 max 16.780 mean 16.528	420		H min 11.098 max 11.105 mean 11.101
347		CPU PAR min 1.192 max 1.298 mean 1.242	421	Row-Gradient	ii iii ii
348		H min 10.738 max 10.742 mean 10.740	422		CPU COO min 0.739 max* 2.092 mean 1.091
349	Row-Gradient		423		CPU CSR min 2.539 max 2.546 mean 2.543
350		CPU COO min 0.709 max* 1.656 mean 0.819	424		GPU 64 COO min 7.040 max 7.150 mean 7.100
351		CPU CSR min 1.527 max 1.535 mean 1.530	425		CSR min 15.520 max 18.560 mean 17.547
352		GPU 64 COO min 8.450 max* 8.680 mean 8.527	426		CPU PAR min 1.401 max 1.661 mean 1.525
353		CSR min 16.520 max*19.480 mean 17.984	427		H min 11.109 max 11.109 mean 11.109
354		CPU PAR min 1.280 max 1.704 mean 1.485	428	Column-Gradient	
355	Caluma Candinas	H min 10.572 max 10.585 mean 10.581	429		CPU COO min 0.726 max 2.065 mean 1.011
356 357	Column-Gradient	CPU COO min 0.698 max 1.042 mean 0.737	430		CPU CSR min 2.539 max 2.550 mean 2.546
358		CPU CSR min 1.458 max 1.536 mean 1.528	431		GPU 64 COO min 6.800 max 7.140 mean 7.080
359		GPU 64 COO min 8.340 max 8.600 mean 8.443	432		CSR min 15.480 max 18.560 mean 16.866
360		CSR min 16.360 max 18.450 mean 17.247	433		CPU PAR min 1.391 max* 1.737 mean 1.563
361		CPU PAR min 1.307 max* 1.712 mean 1.494	434		H min 11.329 max 11.333 mean 11.331
362		H min 10.823 max*10.841 mean 10.835	435	Row-Column-Permute	
363	Row-Column-Permute		436		CPU COO min 0.746 max 0.782 mean 0.754
364		CPU COO min 0.683 max 1.247 mean 0.749	437		CPU CSR min 3.310 max 3.324 mean 3.318
365		CPU CSR min 1.583 max* 1.595 mean 1.590	438		GPU 64 COO min 7.030 max 7.160 mean 7.100
366		GPU 64 COO min 8.370 max 8.500 mean 8.435	439		CSR min 15.730 max 18.530 mean 17.362
367		CSR min 16.250 max 16.780 mean 16.518	440		CPU PAR min 1.340 max 1.451 mean 1.401
368		CPU PAR min 1.206 max 1.291 mean 1.243	441	hlamana mto	H min 11.099 max 11.104 mean 11.102
369		H min 10.738 max 10.742 mean 10.740	442	bloweya.mtx	
			443	Regular	

444		CPU COO min 0.727 max* 1.815 mean 0.892	518	GPU 64 COO min 11.340 max*11.860 mean 11.441
445		CPU CSR min 2.867 max* 2.936 mean 2.917	519	CSR min 36.010 max*40.960 mean 38.048
446		GPU 64 COO min 0.000 max 0.000 mean 0.000	520	CPU PAR min 2.019 max 2.204 mean 2.130
447		CSR min 0.000 max 0.000 mean 0.000	521	H min 8.228 max 8.228 mean 8.228
448		CPU PAR min 1.680 max* 1.751 mean 1.719	522 Row-Premute	11 111 0.225 max 0.225 mcdi 0.225
449				CPU COO min 0.718 max 0.751 mean 0.732
		H min 7.205 max 7.205 mean 7.205	523	
450	Row-Premute		524	CPU CSR min 2.488 max 2.507 mean 2.498
451		CPU COO min 0.678 max 1.483 mean 0.746	525	GPU 64 COO min 10.810 max 11.090 mean 10.949
452		CPU CSR min 2.311 max 2.326 mean 2.320	526	CSR min 24.860 max 26.410 mean 25.527
453		GPU 64 COO min 6.840 max* 7.270 mean 6.930	527	CPU PAR min 1.978 max 2.290 mean 2.135
454		CSR min 15.650 max 16.800 mean 16.233	528	H min 11.836 max 11.840 mean 11.838
455		CPU PAR min 1.649 max 1.730 mean 1.682	529 Row-Gradient	
456		H min 11.026 max 11.031 mean 11.029	530	CPU COO min 0.722 max 1.794 mean 0.769
	Daw Candinat	II IIII II.020 IIIdx III.031 IIIedii II.023		
457	Row-Gradient		531	GIO CON MILIT EL TOT MON EL TET MICON EL TTO
458		CPU COO min 0.708 max 1.209 mean 0.779	532	GPU 64 COO min 11.210 max 11.480 mean 11.317
459		CPU CSR min 1.648 max 1.735 mean 1.709	533	CSR min 31.920 max 34.690 mean 33.246
460		GPU 64 COO min 6.920 max 7.080 mean 7.015	534	CPU PAR min 2.184 max* 2.302 mean 2.232
461		CSR min 16.950 max 19.500 mean 17.794	535	H min 10.742 max 10.757 mean 10.748
462		CPU PAR min 1.497 max 1.743 mean 1.608	536 Column-Gradient	
463		H min 10.298 max 10.304 mean 10.301	537	CPU COO min 0.720 max 0.916 mean 0.742
464	Column-Gradient	11 10.230 max 10.301 medii 10.301	538	CPU CSR min 2.395 max 2.410 mean 2.402
	COTUMNI-GI AUTENC	ONU 000 0 700 1 F2C 0 017		
465		CPU COO min 0.709 max 1.536 mean 0.817	539	GPU 64 COO min 10.840 max 11.070 mean 10.946
466		CPU CSR min 1.705 max 1.753 mean 1.735	540	CSR min 24.340 max 26.140 mean 25.393
467		GPU 64 COO min 6.800 max 7.120 mean 6.865	541	CPU PAR min 2.184 max 2.272 mean 2.223
468		CSR min 15.480 max*17.710 mean 16.470	542	H min 11.873 max 11.882 mean 11.878
469		CPU PAR min 1.446 max 1.718 mean 1.591	543 Row-Column-Permute	
470		H min 10.880 max 10.886 mean 10.883	544	CPU COO min 0.707 max 0.748 mean 0.714
471	Row-Column-Permute	11 111 10:000 max 10:000 mean 10:000	545	CPU CSR min 2.458 max 2.511 mean 2.506
	NOW-COTUMNITY OF MILE	ONU 000 0 670 1 004 0 706		
472		CPU COO min 0.670 max 1.024 mean 0.706	546	GPU 64 COO min 10.880 max 11.070 mean 10.957
473		CPU CSR min 2.199 max 2.340 mean 2.326	547	CSR min 24.890 max 26.490 mean 25.642
474		GPU 64 COO min 6.880 max 6.980 mean 6.933	548	CPU PAR min 2.209 max 2.282 mean 2.240
475		CSR min 15.610 max 16.900 mean 16.227	549	H min 11.834 max*11.840 mean 11.838
476		CPU PAR min 1.598 max 1.668 mean 1.632	550 brainpc2.mtx	
477		H min 11.025 max*11.032 mean 11.029	551 Regular	
478	lp_osa_07.mtx	man rrives max rrives mean rrives	552	CPU COO min 0.732 max 0.751 mean 0.744
	•			
479	Regular		553	CPU CSR min 2.885 max* 2.916 mean 2.909
480		CPU COO min 0.715 max 1.798 mean 0.885	554	GPU 64 COO min 0.000 max 0.000 mean 0.000
481		CPU CSR min 2.495 max 2.551 mean 2.547	555	CSR min 0.000 max 0.000 mean 0.000
482		GPU 64 COO min 7.650 max* 7.790 mean 7.718	556	CPU PAR min 1.276 max 1.299 mean 1.286
483		CSR min 16.390 max*18.350 mean 17.093	557	H min 7.478 max 7.478 mean 7.478
484		CPU PAR min 0.963 max 1.012 mean 0.995	558 Row-Premute	
485		H min 8.412 max 8.412 mean 8.412	559	CPU COO min 0.727 max 0.855 mean 0.736
486	Row-Premute	III O. II MAN O. II MEGII O. II E	560	CPU CSR min 2.385 max 2.411 mean 2.397
	NOW-F1 ellid Le	ODU 000 0 700 0 070 1 104		
487		CPU COO min 0.720 max* 2.078 mean 1.104	561	GPU 64 COO min 8.120 max 8.410 mean 8.206
488		CPU CSR min 2.656 max* 2.679 mean 2.669	562	CSR min 18.670 max 19.960 mean 19.536
489		GPU 64 COO min 7.610 max 7.690 mean 7.647	563	CPU PAR min 1.293 max 1.340 mean 1.314
490		CSR min 15.910 max 17.210 mean 16.750	564	H min 9.809 max 9.813 mean 9.811
491		CPU PAR min 0.890 max 0.940 mean 0.918	565 Row-Gradient	
492		H min 9.255 max 9.258 mean 9.256	566	CPU COO min 0.696 max* 1.546 mean 0.785
493	Row-Gradient		567	CPU CSR min 1.361 max 1.420 mean 1.411
494	Now Gradient	CPU COO min 0.725 max 2.078 mean 1.041		GPU 64 COO min 8.190 max* 8.550 mean 8.302
			568	
495		CPU CSR min 2.487 max 2.502 mean 2.495	569	CSR min 18.700 max*21.000 mean 19.890
496		GPU 64 COO min 7.570 max 7.730 mean 7.655	570	CPU PAR min 1.435 max 1.666 mean 1.549
497		CSR min 15.370 max 18.100 mean 16.803	571	H min 9.721 max 9.727 mean 9.723
498		CPU PAR min 1.435 max 1.796 mean 1.592	572 Column-Gradient	
499		H min 8.637 max 8.678 mean 8.672	573	CPU COO min 0.698 max 1.467 mean 0.746
500	Column-Gradient		574	CPU CSR min 1.377 max 1.423 mean 1.414
501		CPU COO min 0.724 max 1.990 mean 1.000	575	GPU 64 COO min 8.110 max 8.290 mean 8.187
502		CPU CSR min 2.425 max 2.477 mean 2.448	576	CSR min 18.090 max 20.190 mean 19.217
503		GPU 64 COO min 7.510 max 7.660 mean 7.596	577	CPU PAR min 1.345 max* 1.681 mean 1.518
504		CSR min 14.410 max 16.290 mean 15.267	578	H min 10.369 max*10.372 mean 10.370
505		CPU PAR min 1.238 max 1.774 mean 1.534	579 Row-Column-Permute	
506		H min 9.447 max* 9.603 mean 9.576	580	CPU COO min 0.698 max 1.390 mean 0.788
507	Row-Column-Permute		581	CPU CSR min 2.387 max 2.410 mean 2.399
508		CPU COO min 0.738 max 1.950 mean 1.071	582	GPU 64 COO min 8.120 max 8.260 mean 8.191
509		CPU CSR min 2.522 max 2.709 mean 2.675	583	CSR min 18.530 max 19.960 mean 19.307
510		GPU 64 COO min 7.600 max 7.690 mean 7.641	584	CPU PAR min 1.295 max 1.347 mean 1.319
511		CSR min 15.820 max 17.190 mean 16.572	585	H min 9.809 max 9.813 mean 9.811
512		CPU PAR min 0.891 max 0.944 mean 0.924	586 shermanACb.mtx	
513		H min 9.255 max 9.258 mean 9.256	587 Regular	
514	ex19.mtx		588	CPU COO min 0.712 max 1.201 mean 0.756
515	Regular		589	CPU CSR min 1.558 max 1.601 mean 1.596
516	0	CPU COO min 0.732 max* 1.837 mean 1.076	590	GPU 64 COO min 7.080 max* 7.370 mean 7.184
517		CPU CSR min 2.563 max* 2.586 mean 2.577	591	CSR min 17.580 max*19.480 mean 18.770

592		CPU PAR	min	1.286 max	1.511 mean	1.447	666	Row-Premute		
593		Н			8.600 mean		667		CPU COO min 0.724 max 1.100 mean 0.765	5
594	Row-Premute						668		CPU CSR min 2.581 max* 2.626 mean 2.609	9
595		CPU COO	min	0.689 max	0.890 mean	0.704	669		GPU 64 COO min 7.170 max 7.340 mean 7.253	3
596		CPU CSR	min	1.600 max	1.630 mean	1.618	670		CSR min 17.360 max 18.500 mean 18.014	4
597		GPU 64 CO	min	7.000 max	7.180 mean	7.061	671		CPU PAR min 1.494 max* 1.607 mean 1.558	8
598					17.240 mean		672		H min 10.043 max 10.047 mean 10.044	
599		CPU PAR	min	1.296 max	1.419 mean	1.365	673	Row-Gradient		
600		Н	min	10.376 max	10.380 mean	10.379	674		CPU COO min 0.716 max 1.701 mean 0.804	4
601	Row-Gradient						675		CPU CSR min 1.824 max 1.840 mean 1.832	
602		CPU COO	min	0.704 max	1.615 mean	0.806	676		GPU 64 COO min 7.220 max* 7.510 mean 7.303	3
603		CPU CSR			1.370 mean		677		CSR min 17.540 max*20.710 mean 19.302	
604					7.160 mean		678		CPU PAR min 1.384 max 1.593 mean 1.526	
605					16.290 mean		679		H min 9.681 max 9.706 mean 9.694	
606		CPU PAR			1.520 mean		680	Column-Gradient		
607		Н			9.925 mean		681		CPU COO min 0.711 max 1.029 mean 0.746	6
608	Column-Gradient						682		CPU CSR min 1.817 max 1.834 mean 1.827	
609		CPU COO	min	0.702 max	* 1.626 mean	0.844	683		GPU 64 COO min 7.110 max 7.270 mean 7.193	
610		CPU CSR			1.374 mean		684		CSR min 16.530 max 18.590 mean 17.574	
611					7.210 mean		685		CPU PAR min 1.390 max 1.574 mean 1.511	
612					15.260 mean		686		H min 10.612 max*10.659 mean 10.634	
613		CPU PAR			* 1.531 mean		687	Row-Column-Permute	11 10:012 max 10:003 mcan 10:00	
614		Н			10.595 mean		688		CPU COO min 0.719 max 1.391 mean 0.756	6
615	Row-Column-Permute						689		CPU CSR min 2.546 max 2.625 mean 2.611	
616		CPU COO	min	0.707 max	1.532 mean	0.924	690		GPU 64 COO min 7.190 max 7.320 mean 7.248	
617		CPU CSR			* 1.634 mean		691		CSR min 17.500 max 18.640 mean 18.040	
618					7.110 mean		692		CPU PAR min 1.465 max 1.573 mean 1.533	
619					17.310 mean		693		H min 10.041 max 10.046 mean 10.044	
620		CPU PAR			1.406 mean		694	TSOPF_FS_b9_c6.mtx	11 10.041 max 10.040 mean 10.044	7
621		H			10.382 mean		695	Regular		
622	cvxqp3.mtx	"	IIIIII	10.3// IIIdx	10.302 illean	10.375	696	regulai	CPU COO min 0.705 max 0.734 mean 0.718	0
623	Regular						697		CPU CSR min 3.028 max* 3.052 mean 3.045	
624	Regulai	CPU COO	min	0 607 may	0.720 mean	0.712	698		GPU 64 COO min 0.000 max 0.000 mean 0.000	
625		CPU CSR			* 2.643 mean		699		CSR min 0.000 max 0.000 mean 0.000	
626					* 6.220 mean		700		CPU PAR min 1.528 max* 1.602 mean 1.568	
627					*22.710 mean		701		H min 7.380 max 7.380 mean 7.386	
628		CPU PAR			* 1.860 mean		702	Row-Premute	11 III11 7.300 IIIdx 7.300 IIIedii 7.300	U
		H H			8.646 mean			NOW-F1 ellique	CPU COO min 0.733 max 1.640 mean 0.777	7
629	Davi Davanita	п	IIIII	0.040 IIIdX	6.040 Illean	0.040	703			
630	Row-Premute	CPU COO		0 505	* 1.577 mean	0.004	704 705			
631									GPU 64 COO min 7.200 max 7.320 mean 7.268	
632		CPU CSR			2.471 mean		706		CSR min 17.420 max 18.540 mean 18.102	
633					6.060 mean		707		CPU PAR min 1.474 max 1.595 mean 1.546	
634					19.130 mean		708	December 1	H min 10.042 max 10.046 mean 10.044	4
635		CPU PAR			1.833 mean		709	Row-Gradient		_
636		Н	mın	11.028 max	11.033 mean	11.030	710		CPU COO min 0.712 max 0.926 mean 0.756	
637	Row-Gradient	CDU COO		0.000	1 522	0.700	711		CPU CSR min 1.819 max 1.846 mean 1.832	
638		CPU COO			1.523 mean		712		GPU 64 COO min 7.210 max* 7.370 mean 7.298	
639					1.305 mean		713		CSR min 17.550 max*20.740 mean 19.089	
640					6.000 mean		714		CPU PAR min 1.256 max 1.554 mean 1.495	
641					18.410 mean		715	0.1	H min 9.666 max 9.704 mean 9.696	0
642		CPU PAR			1.485 mean		716	Column-Gradient		
643	0.1	Н	mın	II.061 max	11.069 mean	11.064	717		CPU COO min 0.710 max * 1.690 mean 0.791	
644	Column-Gradient	CDII COO	_/	0.602	1 521	0.772	718		Cro Con man 1.015 max 1.050 mcan 1.050	
645		CPU COO			1.521 mean		719		GPU 64 COO min 7.130 max 7.310 mean 7.211	
646		CI O COIL			1.302 mean		720		CSR min 16.550 max 18.690 mean 17.617	
647					6.060 mean		721		CPU PAR min 1.385 max 1.539 mean 1.506	
648					18.330 mean		722		H min 10.611 max*10.659 mean 10.634	4
649		CPU PAR			1.464 mean		723	Row-Column-Permute		
650		Н	min	11.127 max	*11.135 mean	11.130	724		CPU COO min 0.709 max 1.531 mean 0.963	
651	Row-Column-Permute						725		CPU CSR min 2.506 max 2.648 mean 2.622	
652		CPU COO			1.503 mean		726		GPU 64 COO min 7.140 max 7.330 mean 7.244	
653		CPU CSR			2.468 mean		727		CSR min 17.410 max 18.520 mean 18.148	
654					5.980 mean		728		CPU PAR min 1.466 max 1.574 mean 1.528	
655					19.140 mean		729		H min 10.041 max 10.046 mean 10.044	4
656		CPU PAR			1.743 mean		730	OPF_6000.mtx		
657		Н	min	11.028 max	11.035 mean	11.030	731	Regular		
658	case9.mtx						732		CPU COO min 0.714 max 0.731 mean 0.720	
659	Regular						733		CPU CSR min 2.667 max* 2.770 mean 2.720	
660		CPU COO			* 1.800 mean		734		GPU 64 COO min 12.310 max*12.550 mean 12.425	
661		CPU CSR			* 3.046 mean		735		CSR min 39.860 max*43.770 mean 42.075	
662					0.000 mean		736		CPU PAR min 1.735 max 1.945 mean 1.845	
663					0.000 mean		737		H min 8.799 max 8.799 mean 8.799	9
664		CPU PAR			1.605 mean		738	Row-Premute		_
665		Н	min	7.380 max	7.380 mean	7.380	739		CPU COO min 0.689 max 0.710 mean 0.695	5

740		CPU CSR min 2.358 max 2.413 mean 2.392	814	CSR min 19.960 max 21.190 mean 20.696
741		GPU 64 COO min 11.430 max 11.770 mean 11.549	815	CPU PAR min 1.303 max 1.371 mean 1.345
742		CSR min 24.470 max 25.580 mean 24.785	816	H min 10.059 max 10.062 mean 10.061
743		CPU PAR min 1.758 max 1.896 mean 1.829	817 Row-Gradient	
744		H min 11.872 max 11.877 mean 11.875	818	CPU COO min 0.723 max 0.984 mean 0.753
745	Row-Gradient		819	CPU CSR min 1.781 max 1.809 mean 1.803
746		CPU COO min 0.716 max 0.775 mean 0.739	820	GPU 64 COO min 9.380 max 9.660 mean 9.464
747		CPU CSR min 1.651 max 1.689 mean 1.675	821	CSR min 15.770 max 19.090 mean 18.037
748		GPU 64 COO min 12.100 max 12.410 mean 12.205	822	CPU PAR min 1.775 max* 1.924 mean 1.868
749		CSR min 31.670 max 34.910 mean 33.370	823	H min 10.205 max 10.233 mean 10.219
750		CPU PAR min 2.079 max* 2.286 mean 2.207	824 Column-Gradient	
751		H min 11.111 max 11.116 mean 11.113	825	CPU COO min 0.715 max 0.926 mean 0.757
752	Column=Gradient	II IIII III. III III III III III III II	826	CPU CSR min 1.729 max 1.802 mean 1.791
	COTUMN=Gradient	CPU COO min 0.715 max* 1.021 mean 0.743		
753			827	GPU 64 COO min 9.080 max 9.270 mean 9.158
754		CPU CSR min 1.655 max 1.674 mean 1.666	828	CSR min 13.980 max 15.780 mean 14.938
755		GPU 64 COO min 11.340 max 11.560 mean 11.463	829	CPU PAR min 1.751 max 1.906 mean 1.846
756		CSR min 23.770 max 25.470 mean 24.489	830	H min 11.213 max*11.232 mean 11.222
757		CPU PAR min 2.056 max 2.172 mean 2.118	831 Row-Column-Permute	
758		H min 12.040 max*12.047 mean 12.043	832	CPU COO min 0.732 max 1.598 mean 0.785
759	Row-Column-Permute		833	CPU CSR min 2.594 max 2.602 mean 2.599
760		CPU COO min 0.677 max 0.785 mean 0.687	834	GPU 64 COO min 9.340 max 9.460 mean 9.394
761		CPU CSR min 2.325 max 2.434 mean 2.369	835	CSR min 19.950 max 21.500 mean 20.544
762		GPU 64 COO min 11.450 max 11.650 mean 11.538	836	CPU PAR min 1.326 max 1.374 mean 1.354
763		CSR min 24.330 max 25.560 mean 25.008	837	H min 10.059 max 10.062 mean 10.061
764		CPU PAR min 1.631 max 1.776 mean 1.709	838 mhd4800a.mtx	
765		H min 11.873 max 11.877 mean 11.875	839 Regular	
766	OPF 3754.mtx	11 III 11.073 IIIdx 11.077 IIIedii 11.073	840	CPU COO min 0.759 max 0.795 mean 0.780
	· · · ·			
767	Regular		841	
768		CPU COO min 0.726 max 0.774 mean 0.747	842	GPU 64 COO min 5.490 max* 5.650 mean 5.552
769		CPU CSR min 2.898 max* 2.919 mean 2.908	843	CSR min 16.700 max 19.460 mean 18.004
770		GPU 64 COO min 7.680 max* 7.820 mean 7.766	844	CPU PAR min 1.456 max* 1.523 mean 1.492
771		CSR min 25.070 max*29.030 mean 26.756	845	H min 7.132 max 7.132 mean 7.132
772		CPU PAR min 1.437 max 1.508 mean 1.471	846 Row-Premute	
773		H min 8.393 max 8.393 mean 8.393	847	CPU COO min 0.695 max 0.943 mean 0.726
774	Row-Premute		848	CPU CSR min 2.480 max 2.488 mean 2.485
775		CPU COO min 0.714 max* 1.574 mean 0.817	849	GPU 64 COO min 5.410 max 5.490 mean 5.453
776		CPU CSR min 2.686 max 2.711 mean 2.699	850	CSR min 15.700 max 17.520 mean 16.678
777		GPU 64 COO min 7.410 max 7.570 mean 7.484	851	CPU PAR min 1.422 max 1.514 mean 1.474
778		CSR min 19.600 max 21.190 mean 20.307	852	H min 10.959 max 10.966 mean 10.963
779		CPU PAR min 1.443 max 1.505 mean 1.469	853 Row-Gradient	11 10.355 max 10.366 mean 10.365
780		H min 11.267 max 11.272 mean 11.269	854	CPU COO min 0.723 max* 2.029 mean 0.990
	Daw Candinat	11 III11 11.207 IIIAX 11.272 IIIEAN 11.209		
781	Row-Gradient		855	CPU CSR min 2.411 max 2.427 mean 2.421
782		CPU COO min 0.723 max 1.232 mean 0.775	856	GPU 64 COO min 5.490 max 5.560 mean 5.534
783		CPU CSR min 1.672 max 1.691 mean 1.685	857	CSR min 16.350 max*19.560 mean 17.784
784		GPU 64 COO min 7.600 max 7.760 mean 7.716	858	CPU PAR min 1.441 max 1.509 mean 1.477
785		CSR min 23.160 max 25.590 mean 24.304	859	H min 9.512 max 9.526 mean 9.520
786		CPU PAR min 1.675 max* 1.736 mean 1.703	860 Column-Gradient	
787		H min 10.463 max 10.472 mean 10.468	861	CPU COO min 0.721 max 1.802 mean 0.871
788	Column-Gradient		862	CPU CSR min 2.393 max 2.408 mean 2.404
789		CPU COO min 0.726 max 1.431 mean 0.778	863	GPU 64 COO min 5.410 max 5.480 mean 5.453
790		CPU CSR min 1.671 max 1.685 mean 1.679	864	CSR min 15.680 max 17.870 mean 16.540
791		GPU 64 COO min 7.410 max 7.530 mean 7.467	865	CPU PAR min 1.429 max 1.488 mean 1.468
792		CSR min 18.140 max 20.350 mean 19.315	866	H min 10.931 max 10.945 mean 10.938
793		CPU PAR min 1.650 max 1.736 mean 1.699	867 Row-Column-Permute	
794		H min 11.393 max*11.401 mean 11.397	868	CPU COO min 0.728 max 1.646 mean 1.037
795	Row-Column-Permute		869	CPU CSR min 2.472 max 2.488 mean 2.480
796	III. I CI Macc	CPU COO min 0.711 max 1.458 mean 0.751	870	GPU 64 COO min 5.410 max 5.480 mean 5.449
797			871	CSR min 15.760 max 17.560 mean 16.654
798		GPU 64 COO min 7.400 max 7.540 mean 7.471	872	CPU PAR min 1.428 max 1.513 mean 1.474
799		CSR min 19.560 max 21.150 mean 20.453	873	H min 10.959 max*10.967 mean 10.963
800		CPU PAR min 1.440 max 1.499 mean 1.467	874 gen4.mtx	
801		H min 11.266 max 11.272 mean 11.269	875 Regular	
802	c-47.mtx		876	CPU COO min 0.737 max 1.977 mean 1.431
803	Regular		877	CPU CSR min 2.674 max 2.688 mean 2.681
804		CPU COO min 0.754 max* 1.829 mean 1.204	878	GPU 64 COO min 5.900 max 6.000 mean 5.954
805		CPU CSR min 2.610 max* 2.624 mean 2.618	879	CSR min 13.650 max 15.410 mean 14.657
806		GPU 64 COO min 9.530 max* 9.870 mean 9.640	880	CPU PAR min 1.468 max 1.521 mean 1.491
807		CSR min 23.990 max*25.910 mean 24.992	881	H min 9.234 max 9.234 mean 9.234
808		CPU PAR min 1.311 max 1.380 mean 1.357	882 Row-Premute	
809		H min 8.364 max 8.364 mean 8.364	883	CPU COO min 0.740 max* 2.048 mean 1.121
810	Row-Premute	min 0.501 max 0.504 mean 0.504	884	CPU CSR min 2.777 max 2.798 mean 2.790
811	NOW I TEMBLE	CPU COO min 0.740 max 0.885 mean 0.755		GPU 64 COO min 5.910 max 5.970 mean 5.944
			885	
812		CPU CSR min 2.574 max 2.611 mean 2.597	886	CSR min 13.700 max 15.370 mean 14.541
813		GPU 64 COO min 9.320 max 9.510 mean 9.397	887	CPU PAR min 1.468 max 1.546 mean 1.502

888		H min 10.250 max 10.255 mea			PU COO min 0.735 max 1.806 mean 0.878
889	Row-Gradient		963	,	PU CSR min 2.706 max 2.744 mean 2.726
890		CPU COO min 0.740 max 1.790 mea		(PU 64 COO min 6.390 max 6.500 mean 6.433
891		CPU CSR min 2.663 max 2.682 mea			CSR min 19.780 max 22.870 mean 20.936
892		GPU 64 COO min 5.890 max* 6.160 mea			PU PAR min 1.710 max 1.865 mean 1.785
893		CSR min 13.780 max*17.520 mea	an 15.601 967	H	min 10.251 max 10.267 mean 10.257
894		CPU PAR min 1.479 max* 1.619 mea	an 1.569 968	Column-Gradient	
895		H min 9.939 max 9.955 mea	an 9.948 969	(PU COO min 0.728 max 1.792 mean 0.986
896	Column-Gradient		970	(PU CSR min 2.521 max 2.720 mean 2.703
897		CPU COO min 0.743 max 1.991 mea	an 0.981 971		PU 64 COO min 6.280 max 6.370 mean 6.327
898		CPU CSR min 2.620 max 2.654 mea	an 2.646 972		CSR min 18.000 max 19.720 mean 19.040
899		GPU 64 COO min 5.840 max 5.910 mea	an 5.885 973		PU PAR min 1.649 max 1.741 mean 1.702
900		CSR min 13.130 max 17.040 mea	an 15.008 974	H	min 11.113 max 11.121 mean 11.117
901		CPU PAR min 1.477 max 1.607 mea	an 1.559 975	Row-Column-Permute	
902		H min 10.858 max*10.876 mea	an 10.864 976		PU COO min 0.714 max 1.525 mean 0.957
903	Row-Column-Permute		977		PU CSR min 2.876 max 2.892 mean 2.884
904		CPU COO min 0.742 max 2.010 mea	an 1.124 978		PU 64 COO min 6.280 max 6.370 mean 6.322
905		CPU CSR min 2.789 max* 2.800 mea			CSR min 17.960 max 19.670 mean 18.670
906		GPU 64 COO min 5.900 max 5.980 mea			PU PAR min 1.667 max 1.754 mean 1.710
907		CSR min 13.640 max 15.410 mea			NOTAL MILITARION MAKE TEACH TEACH TEACH
908		CPU PAR min 1.462 max 1.540 mea		TSOPF_RS_b39_c7.mtx	
909		H min 10.250 max 10.253 mea		Regular	
	M	n min 10.250 max 10.253 mea			PH 000 0 771 0 702 0 700
910	Maragal_6.mtx		984		PU COO min 0.771 max 0.793 mean 0.780
911	Regular		985		PU CSR min 3.219 max* 3.232 mean 3.227
912		CPU COO min 0.725 max 0.741 mea		C	PU 64 COO min 11.070 max*11.200 mean 11.142
913		CPU CSR min 2.345 max 2.409 mea	an 2.372 987		CSR min 37.050 max*42.100 mean 39.040
914		GPU 64 COO min 18.200 max 18.770 mea	an 18.357 988	(PU PAR min 1.910 max 2.027 mean 1.982
915		CSR min 38.310 max*40.240 mea	an 39.477 989	H	min 7.304 max 7.304 mean 7.304
916		CPU PAR min 0.789 max 0.813 mea	an 0.797 990	Row-Premute	
917		H min 9.930 max 9.930 mea	an 9.930 991	(PU COO min 0.701 max 0.722 mean 0.707
918	Row-Premute		992		PU CSR min 2.931 max 2.952 mean 2.942
919		CPU COO min 0.709 max 0.779 mea	an 0.715 993		PU 64 COO min 10.860 max 11.030 mean 10.928
920		CPU CSR min 2.675 max 2.715 mea			CSR min 28.730 max 30.880 mean 29.483
921		GPU 64 COO min 17.810 max 18.030 mea		(PU PAR min 1.760 max 1.922 mean 1.851
922		CSR min 29.650 max 30.580 mea		ŀ	
923		CPU PAR min 0.857 max 0.940 mea		Row-Gradient	1 10.337 max 10.341 mean 10.333
					PU COO min 0.747 max 0.808 mean 0.757
924		H min 10.777 max 10.779 mea			
925	Row-Gradient		999		PU CSR min 2.606 max 2.648 mean 2.624
926		CPU COO min 0.710 max* 1.566 mea		(PU 64 COO min 10.850 max 11.120 mean 10.999
927		CPU CSR min 2.042 max 2.159 mea			CSR min 33.910 max 37.600 mean 35.909
928		GPU 64 COO min 18.460 max*18.960 mea	an 18.665 1002	(PU PAR min 2.154 max* 2.245 mean 2.203
929		CSR min 25.650 max 27.330 mea	an 26.549 1003	ŀ	min 9.636 max 9.646 mean 9.642
930		CPU PAR min 2.257 max 2.612 mea	an 2.416 1004	Column-Gradient	
931		H min 11.251 max 11.301 mea	an 11.285 1005	(PU COO min 0.718 max* 1.693 mean 0.802
932	Column-Gradient		1006	(PU CSR min 2.502 max 2.585 mean 2.547
933		CPU COO min 0.711 max 0.743 mea	an 0.725 1007	(PU 64 COO min 10.700 max 10.990 mean 10.804
934		CPU CSR min 2.036 max 2.161 mea	an 2.110 1008		
935					CSR min 27.230 max 29.380 mean 28.488
936		GPU 64 COO min 17.840 max 18.860 mea	an 18.149 1009		CSR min 27.230 max 29.380 mean 28.488 CPU PAR min 2.128 max 2.227 mean 2.172
937		GPU 64 COO min 17.840 max 18.860 mea			PU PAR min 2.128 max 2.227 mean 2.172
		CSR min 19.410 max 20.690 mea	an 20.066 1010	H	PU PAR min 2.128 max 2.227 mean 2.172
		CSR min 19.410 max 20.690 mea	an 20.066 1010 an 2.349 1011	Row-Column-Permute	PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208
938	Row-Column-Permute	CSR min 19.410 max 20.690 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012	Row-Column-Permute	PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 PU COO min 0.709 max 0.726 mean 0.716
938 939	Row-Column-Permute	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012	Row-Column-Permute (PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 PU COO min 0.709 max 0.726 mean 0.716 PU CSR min 2.917 max 2.958 mean 2.940
938 939 940	Row-Column-Permute	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014	Row-Column-Permute (PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 PU COO min 0.709 max 0.726 mean 0.716 PU CSR min 2.917 max 2.958 mean 2.940 PU 64 COO min 10.840 max 11.030 mean 10.930
938 939 940 941	Row-Column-Permute	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015	Row-Column-Permute (PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 PU COO min 0.709 max 0.726 mean 0.716 PU CSR min 2.917 max 2.958 mean 2.940 FU 64 COO min 10.840 max 11.030 mean 10.930 CSR min 28.780 max 30.810 mean 29.578
938 939 940 941 942	Row-Column-Permute	CPU PAR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea GPU 64 COO min 17.720 max 18.070 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015 an 17.911 1016	Row-Column-Permute	PU PAR min 2.128 max 2.227 mean 2.172 min 11.31 max*11.222 mean 11.208 PU COO min 0.709 max 0.726 mean 0.716 PU CSR min 2.917 max 2.958 mean 2.940 CSR min 28.780 max 30.810 mean 10.930 CSR min 28.780 max 30.810 mean 29.578 PU PAR min 1.757 max 1.834 mean 1.792
938 939 940 941 942 943	Row-Column-Permute	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea GPU 64 COO min 17.720 max 18.670 mea CSR min 29.600 max 30.500 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015 an 17.911 1016 an 29.961 1017	Row-Column-Permute (PU PAR min 2.128 max 2.227 mean 2.172 min 11.31 max*11.222 mean 11.208 PU COO min 0.709 max 0.726 mean 0.716 PU CSR min 2.917 max 2.958 mean 2.940 CSR min 28.780 max 30.810 mean 10.930 CSR min 28.780 max 30.810 mean 29.578 PU PAR min 1.757 max 1.834 mean 1.792
938 939 940 941 942	Row-Column-Permute	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea GPU 64 COO min 17.720 max 18.070 mea CSR min 29.600 max 38.500 mea CPU PAR min 0.827 max 0.954 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015 an 17.911 1016 an 29.961 1017 an 0.913	Row-Column-Permute	PU PAR min 2.128 max 2.227 mean 2.172 min 11.31 max*11.222 mean 11.208 PU COO min 0.709 max 0.726 mean 0.716 PU CSR min 2.917 max 2.958 mean 2.940 CSR min 28.780 max 30.810 mean 10.930 CSR min 28.780 max 30.810 mean 29.578 PU PAR min 1.757 max 1.834 mean 1.792
938 939 940 941 942 943	Row-Column-Permute	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea GPU 64 COO min 17.720 max 18.670 mea CSR min 29.600 max 30.500 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015 an 17.911 1016 an 29.961 1017 an 0.913	Row-Column-Permute	PU PAR min 2.128 max 2.227 mean 2.172 min 11.31 max*11.222 mean 11.208 PU COO min 0.709 max 0.726 mean 0.716 PU CSR min 2.917 max 2.958 mean 2.940 CSR min 28.780 max 30.810 mean 10.930 CSR min 28.780 max 30.810 mean 29.578 PU PAR min 1.757 max 1.834 mean 1.792
938 939 940 941 942 943	Row-Column-Permute	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea GPU 64 COO min 17.720 max 18.070 mea CSR min 29.600 max 38.500 mea CPU PAR min 0.827 max 0.954 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015 an 17.911 1016 an 29.961 1017 an 0.913 an 10.777	Row-Column-Permute (PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 min 0.709 max 0.726 mean 0.716 mean 0.716 mean 2.917 max 2.958 mean 2.940 mean 10.640 min 10.840 max 11.030 mean 10.930 mean 10.840 max 30.816 mean 29.578 min 28.780 max 30.816 mean 29.578 min 10.537 max 10.540 mean 10.539
938 939 940 941 942 943 944		CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea GPU 64 COO min 17.720 max 18.070 mea CSR min 29.600 max 38.500 mea CPU PAR min 0.827 max 0.954 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015 an 17.911 1016 an 29.961 1017 an 0.913	Row-Column-Permute	PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 min 0.709 max 0.726 mean 0.716 mean 0.716 mean 2.917 max 2.958 mean 2.940 mean 10.640 min 10.840 max 11.030 mean 10.930 mean 10.840 max 30.816 mean 29.578 min 28.780 max 30.816 mean 29.578 min 10.537 max 10.540 mean 10.539
938 939 940 941 942 943 944 945	aft01.mtx	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea GPU 64 COO min 17.720 max 18.070 mea CSR min 29.600 max 38.500 mea CPU PAR min 0.827 max 0.954 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015 an 17.911 1016 an 29.961 1017 an 0.913 an 10.777	Row-Column-Permute (PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 min 0.709 max 0.726 mean 0.716 mean 0.716 mean 2.917 max 2.958 mean 2.940 mean 10.640 min 10.840 max 11.030 mean 10.930 mean 10.840 max 30.816 mean 29.578 min 28.780 max 30.816 mean 29.578 min 10.537 max 10.540 mean 10.539
938 939 940 941 942 943 944 945 946 947	aft01.mtx	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea GPU 64 COO min 17.720 max 18.070 mea CSR min 29.600 max 30.500 mea CPU PAR min 0.827 max 0.954 mea H min 10.776 max 10.778 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015 an 17.911 1016 an 29.961 1017 an 0.913 an 10.777 1018 an 1.069 1019	Row-Column-Permute	PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 min 0.709 max 0.726 mean 0.716 mean 0.716 mean 2.917 max 2.958 mean 2.940 mean 10.640 min 10.840 max 11.030 mean 10.930 mean 10.840 max 30.816 mean 29.578 min 28.780 max 30.816 mean 29.578 min 10.537 max 10.540 mean 10.539
938 939 940 941 942 943 944 945 946 947	aft01.mtx	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea GPU 64 COO min 17.720 max 18.070 mea CSR min 29.600 max 38.500 mea CPU PAR min 0.827 max 0.954 mea H min 10.776 max 10.778 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015 an 2.743 1015 an 0.913 an 0.913 an 0.913 an 10.777 1018 an 1.069 1019 an 3.145 1020	Row-Column-Permute	PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 0.709 max 0.726 mean 0.716 mean 2.917 max 2.958 mean 2.940 min 2.917 max 2.958 mean 2.940 min 10.840 max 11.030 mean 10.930 min 28.780 max 30.810 mean 29.578 min 17.757 max 1.834 mean 1.792 min 10.537 max 10.540 mean 10.539
938 939 940 941 942 943 944 945 946 947 948 949	aft01.mtx	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea CPU 64 COO min 17.720 max 18.070 mea CSR min 2.600 max 30.500 mea CSR min 0.827 max 0.994 mea H min 10.776 max 10.778 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015 an 17.911 1016 an 129.961 1017 an 0.913 an 10.777 1018 an 1.069 1019 an 3.145 1020 an 6.457 1021	Row-Column-Permute	PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 0.709 max 0.726 mean 0.716 min 0.709 max 2.958 mean 2.940 min 2.917 max 2.958 mean 2.940 min 10.840 max 11.030 mean 10.930 min 28.780 max 30.810 mean 10.930 min 10.537 max 1.834 mean 1.792 min 10.537 max 10.540 mean 10.539 min 10.537 max 10.540 mean 10.539
938 939 940 941 942 943 944 945 946 947 948 949 950 951	aft01.mtx	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea CPU CSR min 29.600 max 18.070 mea CPU PAR min 0.827 max 0.954 mea H min 10.776 max 10.778 mea CPU COO min 0.735 max* 2.079 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015 an 17.911 1016 an 29.961 1017 an 0.913 an 10.777 1018 an 1.069 1019 an 3.145 1020 an 6.457 1021 an 21.820 1022	Row-Column-Permute	PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 11.208 min 2.917 max 2.958 mean 2.940 min 2.917 max 2.958 mean 2.940 min 2.878 min 28.780 max 30.810 mean 10.930 min 10.837 max 10.540 mean 10.539 min 10.537 max 10.540 mean 10.539 min 10.540 max* 4.280 mean 4.186 min 9.660 max* 4.280 mean 11.485
938 939 940 941 942 943 944 945 946 947 948 949 950 951 952	aft01.mtx	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea GPU 64 COO min 17.720 max 18.070 mea CSR min 29.600 max 38.500 mea CPU PAR min 0.827 max 0.954 mea H min 10.776 max 10.778 mea CPU COO min 0.735 max* 2.079 mea CPU CSR min 3.132 max* 3.154 mea GPU 64 COO min 6.390 max* 6.610 mea CSR min 19.990 max* 23.256 mea CPU PAR min 1.746 max* 1.865 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015 an 17.911 1016 an 29.961 1017 an 0.913 an 10.777 1018 an 1.069 1019 an 3.145 1020 an 1.812 1023	Row-Column-Permute	PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 11.208 min 2.917 max 2.958 mean 2.940 min 2.917 max 2.958 mean 2.940 min 10.840 max 11.030 mean 10.930 min 10.840 max 11.030 mean 10.930 min 10.537 max 10.540 mean 1.792 min 10.537 max 10.540 mean 10.539 min 10.540 mean 10.539 min 10.540 mean 10.539 min 10.540 mean 10.540 mea
938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953	aft01.mtx Regular	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea CPU CSR min 29.600 max 18.070 mea CPU PAR min 0.827 max 0.954 mea H min 10.776 max 10.778 mea CPU COO min 0.735 max* 2.079 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015 an 27.951 1017 an 0.913 an 0.913 an 10.777 1018 an 1.069 1019 an 3.145 1020 an 6.457 1021 an 21.820 1022 an 1.812 1023 an 7.811 1024	Row-Column-Permute	PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 0.709 max 0.726 mean 0.716 min 0.709 max 2.958 mean 2.940 min 2.917 max 2.958 mean 2.940 min 10.840 max 11.030 mean 10.930 min 128.780 max 30.810 mean 29.578 min 128.780 max 30.810 mean 10.930 min 10.537 max 1.834 mean 1.792 min 10.537 max 10.540 mean 10.539 min 10.537 max 10.540 mean 10.539 min 10.537 max 10.540 mean 11.485 min 9.660 max*12.660 mean 11.485 min 7.811 max 7.811 max 7.811 max 7.811
938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954	aft01.mtx	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea CPU COO min 17.720 max 18.070 mea CPU PAR min 0.827 max 0.954 mea H min 10.776 max 10.778 mea CPU COO min 0.735 max* 2.079 mea CPU CSR min 3.132 max* 3.154 mea CPU CSR min 3.132 max* 3.154 mea CPU CSR min 19.990 max*2.250 mea CPU PAR min 1.746 max* 1.865 mea H min 7.811 max 7.811 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015 an 17.911 1016 an 29.961 1017 an 0.913 an 10.777 1018 an 1.069 1019 an 3.145 1020 an 6.457 1021 an 21.820 1022 an 1.812 1023 an 7.811 1024	Row-Column-Permute	PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 2.917 max 2.958 mean 2.940 mpu 64 COO min 10.840 max 11.030 mean 10.930 min 10.837 max 1.834 mean 11.792 min 10.537 max 1.834 mean 10.539 min 10.537 max 10.540 mean 10.539 min 10.537 max 10.540 mean 11.485 min 7.811 max 7.811 mean 7.811 max 7.811 mean 7.811 mean 7.811 mean 7.811 mean 7.811 mean 4.001
938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955	aft01.mtx Regular	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea CPU CSR min 29.600 max 18.070 mea CPU PAR min 0.827 max 0.954 mea H min 10.776 max 10.778 mea CPU COO min 0.735 max* 2.079 mea CPU CSR min 3.132 max* 3.154 mea CPU CSR min 19.990 max*23.250 mea CPU CSR min 19.990 max*23.250 mea CPU PAR min 1.746 max* 1.865 mea H min 7.811 max 7.811 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015 an 17.911 1016 an 29.961 1017 an 0.913 an 10.777 1018 an 1.069 1019 an 3.145 1020 an 6.457 1021 an 21.820 1022 an 1.812 1023 an 7.811 1024 1025 an 0.840 1026	Row-Column-Permute	PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 2.917 max 2.958 mean 2.940 min 2.917 max 2.958 mean 2.940 min 10.834 mean 11.930 mean 11.930 min 1.757 max 11.834 mean 1.792 min 10.537 max 10.540 mean 10.539 min 10.537 max 10.540 mean 10.539 min 10.537 max 10.540 mean 11.485 min 7.811 mean 9.936 min 9.520 max 4.090 mean 4.001 min 9.520 max 4.090 mean 4.001 min 9.520 max 4.090 mean 4.001 min 9.520 max 10.340 mean 9.936
938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956	aft01.mtx Regular	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea GPU 64 COO min 17.720 max 18.070 mea CSR min 29.600 max 38.500 mea CPU PAR min 0.827 max 0.954 mea H min 10.776 max 10.778 mea CPU COO min 0.735 max* 2.079 mea CPU CSR min 3.132 max* 3.154 mea GPU 64 COO min 6.390 max* 6.610 mea CSR min 19.990 max* 23.256 mea CPU PAR min 1.746 max* 1.865 mea H min 7.811 max 7.811 mea CPU COO min 0.714 max 1.648 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015 an 17.911 1016 an 29.961 1017 an 0.913 an 10.777 1018 an 1.069 1019 an 3.145 1020 an 1.812 1023 an 1.812 1023 an 7.811 1024 an 0.840 1026 an 0.840 1026 an 0.840 1026 an 0.849 1027	Row-Column-Permute	PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 2.917 max 2.958 mean 2.940 min 2.917 max 2.958 mean 2.940 min 10.834 mean 11.930 mean 11.930 min 1.757 max 1.834 mean 1.792 min 10.537 max 10.540 mean 10.539 min 10.537 max 10.540 mean 10.539 min 10.537 max 10.540 mean 11.485 min 7.811 mean 9.936 min 9.520 max 4.090 mean 4.001 min 9.520 max 4.090 mean 4.001 min 9.520 max 10.340 mean 9.936
938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957	aft01.mtx Regular	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea CPU CSR min 29.600 max 30.500 mea CPU PAR min 0.827 max 0.954 mea H min 10.776 max 10.778 mea CPU COO min 0.735 max* 2.079 mea CPU CSR min 3.132 max* 3.154 mea CPU CSR min 19.990 max*23.250 mea CPU PAR min 1.746 max* 1.865 mea CPU PAR min 1.746 max* 1.865 mea CPU COO min 0.714 max 1.648 mea CPU CSR min 1.648 mea CPU CSR min 2.864 max 2.892 mea GPU G4 COO min 6.280 max 6.380 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 17.911 1016 an 29.961 1017 an 0.913 an 10.777 1018 an 1.069 1019 an 3.145 1020 an 6.457 1021 an 21.820 1022 an 7.811 1024 an 7.811 1024 an 0.840 1026	Row-Column-Permute	PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 2.917 max 2.958 mean 2.940 min 2.917 max 2.958 mean 2.940 min 128.730 max 38.810 mean 10.930 min 128.730 max 38.810 mean 10.930 min 128.730 max 18.34 mean 1.792 min 10.537 max 10.540 mean 10.539 min 10.537 max 10.540 mean 11.455 min 7.811 max 7.811 mean 7.811 mean 7.811 mean 7.811 mean 7.811 mean 9.936 min 11.161 max 10.340 mean 4.001 min 11.161 max 11.167 mean 11.165
938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956	aft01.mtx Regular	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea CPU CAR min 0.827 max 10.954 mea CPU PAR min 0.827 max 0.954 mea H min 10.776 max 10.778 mea CPU COO min 0.735 max* 2.079 mea CPU CSR min 39.600 max 30.500 mea CPU PAR min 0.827 max 0.954 mea H min 10.776 max 10.778 mea CPU CSR min 31.32 max* 3.154 mea CPU CSR min 19.990 max*23.250 mea CPU PAR min 1.746 max* 1.865 mea H min 7.811 max 7.811 mea CPU COO min 0.714 max 1.648 mea CPU COO min 0.714 max 1.648 mea CPU COR min 2.864 max 2.892 mea CPU CSR min 2.864 max 2.892 mea CPU CSR min 17.980 max 19.700 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015 an 17.911 1016 an 29.961 1017 an 0.913 an 10.777 1018 an 1.0777 1018 an 3.145 1020 an 6.457 1021 an 21.820 1022 an 1.812 1023 an 7.811 1024 1025 an 6.840 1026 an 6.840 1026 an 1.883 1027 an 6.829 1028 an 1.8840 1026 an 6.840 1026 an 6.829 1028 an 1.883 1027 an 6.829 1028 an 1.883 1027 an 6.829 1028 an 1.8101	Row-Column-Permute	PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 2.917 max 2.958 mean 2.940 min 2.917 max 2.958 mean 2.940 min 10.834 mean 11.930 mean 11.930 min 1.757 max 11.834 mean 1.792 min 10.537 max 10.540 mean 10.539 min 10.537 max 10.540 mean 10.539 min 10.537 max 10.540 mean 11.485 min 7.811 mean 9.936 min 9.520 max 4.090 mean 4.001 min 9.520 max 4.090 mean 4.001 min 9.520 max 4.090 mean 4.001 min 9.520 max 10.340 mean 9.936
938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957	aft01.mtx Regular	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea CPU CSR min 2.9600 max 18.070 mea CPU PAR min 0.827 max 0.954 mea H min 10.776 max 10.778 mea CPU COO min 0.735 max* 2.079 mea CPU CSR min 3.132 max* 3.154 mea CPU CSR min 19.990 max* 6.610 mea CPU CSR min 19.990 max* 23.250 mea CPU PAR min 1.746 max* 1.865 mea H min 7.811 max 7.811 mea CPU COO min 0.714 max 1.648 mea CPU CSR min 2.864 max 2.892 mea CPU COO min 0.714 max 1.648 mea CPU CSR min 2.864 max 2.892 mea CPU COO min 0.714 max 1.648 mea CPU CSR min 1.866 max 6.380 mea CSR min 1.7980 max 1.6700 mea CPU PAR min 1.7980 max 1.700 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015 an 17.911 1016 an 29.961 1017 an 0.913 an 10.777 1018 an 1.069 1019 an 3.145 1020 an 6.457 1021 an 21.820 1022 an 1.812 1023 an 7.811 1024 an 2.883 1027 an 0.840 1026 an 2.883 1027 an 0.840 1026 an 2.883 1027 an 1.9105 1029 an 1.9115 1029	Row-Column-Permute	PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 2.917 max 2.958 mean 2.940 min 2.917 max 2.958 mean 2.940 min 10.834 max 11.033 mean 10.930 min 10.840 max 11.033 mean 10.930 min 10.537 max 10.540 mean 10.539 min 10.537 max 10.540 mean 10.539 min 10.537 max 10.540 mean 11.485 min 7.811 max 7.811 mean 7.811 mean 7.811 max 7.811 mean 9.936 min 11.161 max 11.167 mean 11.165 min 11.161 max 11.167 mean 11.165 min 11.161 max 4.240 mean 4.135 min 5.890 max 4.240 mean 4.135 min 11.161 max 4.240 mean 4.135 min 11.60 max 4.240 mean 4.135 min 11.61 max 4.240 mean 4.135 min 5.890 max 4.090 mean 4.001 min 11.161 max 4.240 mean 4.135 min 5.890 max 4.1350 mean 6.882
938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958	aft01.mtx Regular	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea CPU CAR min 0.827 max 10.954 mea CPU PAR min 0.827 max 0.954 mea H min 10.776 max 10.778 mea CPU COO min 0.735 max* 2.079 mea CPU CSR min 39.600 max 30.500 mea CPU PAR min 0.827 max 0.954 mea H min 10.776 max 10.778 mea CPU CSR min 31.32 max* 3.154 mea CPU CSR min 19.990 max*23.250 mea CPU PAR min 1.746 max* 1.865 mea H min 7.811 max 7.811 mea CPU COO min 0.714 max 1.648 mea CPU COO min 0.714 max 1.648 mea CPU COR min 2.864 max 2.892 mea CPU CSR min 2.864 max 2.892 mea CPU CSR min 17.980 max 19.700 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015 an 17.911 1016 an 29.961 1017 an 0.913 an 10.777 1018 an 1.069 1019 an 3.145 1020 an 6.457 1021 an 21.820 1022 an 1.812 1023 an 7.811 1024 an 2.883 1027 an 0.840 1026 an 2.883 1027 an 0.840 1026 an 2.883 1027 an 1.9105 1029 an 1.9115 1029	Row-Column-Permute	PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 2.917 max 2.958 mean 2.940 min 2.917 max 2.958 mean 2.940 min 10.834 mean 11.930 mean 11.930 min 1.757 max 1.834 mean 1.792 min 10.537 max 10.540 mean 10.539 min 10.537 max 10.540 mean 10.539 min 10.537 max 10.540 mean 11.485 min 7.811 mean 7.811 mean 7.811 mean 7.811 mean 9.936 min 11.161 max 11.167 mean 11.165 min 11.161 max 11.167 mean 11.165 min 4.010 max 4.240 mean 4.135 min 5.890 max 4.240 mean 4.135 min 5.890 max 4.240 mean 4.135 min 5.890 max 4.240 mean 4.135 min 11.161 max 4.240 mean 4.135 min 5.890 max 4.1350 mean 6.882
938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959	aft01.mtx Regular	CSR min 19.410 max 20.690 mea CPU PAR min 2.174 max* 2.546 mea H min 12.011 max*12.072 mea CPU COO min 0.712 max 0.971 mea CPU CSR min 2.732 max* 2.751 mea CPU CSR min 2.9600 max 18.070 mea CPU PAR min 0.827 max 0.954 mea H min 10.776 max 10.778 mea CPU COO min 0.735 max* 2.079 mea CPU CSR min 3.132 max* 3.154 mea CPU CSR min 19.990 max* 6.610 mea CPU CSR min 19.990 max* 23.250 mea CPU PAR min 1.746 max* 1.865 mea H min 7.811 max 7.811 mea CPU COO min 0.714 max 1.648 mea CPU CSR min 2.864 max 2.892 mea CPU COO min 0.714 max 1.648 mea CPU CSR min 2.864 max 2.892 mea CPU COO min 0.714 max 1.648 mea CPU CSR min 1.866 max 6.380 mea CSR min 1.7980 max 1.6700 mea CPU PAR min 1.7980 max 1.700 mea	an 20.066 1010 an 2.349 1011 an 12.052 1012 1013 an 0.737 1014 an 2.743 1015 an 17.911 1016 an 29.961 1017 an 0.913 an 10.777 1018 an 1.069 1019 an 3.145 1020 an 6.457 1021 an 21.820 1022 an 1.812 1023 an 7.811 1024 an 2.883 1027 an 0.840 1026 an 2.883 1027 an 0.840 1026 an 2.883 1027 an 1.9105 1029 an 1.9115 1029	Row-Column-Permute	PU PAR min 2.128 max 2.227 mean 2.172 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 11.131 max*11.222 mean 11.208 min 11.208 min 2.917 max 2.958 mean 2.940 min 2.917 max 2.958 mean 2.940 min 10.834 max 11.030 mean 10.930 min 10.840 max 11.030 mean 10.930 min 10.537 max 10.540 mean 10.539 min 10.537 max 10.540 mean 10.539 min 10.537 max 10.540 mean 11.485 min 7.811 max 7.811 mean 7.811 mean 7.811 max 7.811 mean 9.936 min 11.161 max 11.167 mean 11.165 min 11.161 max 11.167 mean 11.165 min 11.161 max 11.167 mean 11.165 min 5.890 max 4.240 mean 4.135 min 5.890 max 4.240 mean 4.135 min 11.161 max 4.240 mean 4.135 min 11.161 max 4.240 mean 4.135 min 5.890 max 4.240 mean 4.135 min 5.890 max 4.240 mean 4.135 min 5.890 max 4.240 mean 4.135 mean 6.882

1033		GPU 64 COO min 3.850 max 4.100 mean 4.012	1107	H min 7.380 max 7.380 mean 7.380
1034		CSR min 5.460 max 8.790 mean 6.005	1108 Row-Premute	
1035		H min 11.112 max 11.122 mean 11.117	1109	GPU 64 COO min 4.820 max 4.940 mean 4.859
1036	Row-Column-Permute		1110	CSR min 5.080 max 6.520 mean 6.342
1037		GPU 64 COO min 3.850 max 4.080 mean 3.990	1111 1112 - Day Candinat	H min 10.042 max 10.047 mean 10.044
1038 1039		CSR min 5.420 max 6.760 mean 5.977 H min 11.162 max*11.169 mean 11.165	1112 Row-Gradient 1113	GPU 64 COO min 4.810 max* 4.940 mean 4.876
1040	bloweya.mtx	11 IIII 11.102 IIIAX^11.103 IIIEAII 11.103	1114	CSR min 6.100 max* 6.560 mean 6.307
1041	Regular		1115	H min 9.681 max 9.704 mean 9.694
1042		GPU 64 COO min 0.000 max 0.000 mean 0.000	1116 Column-Gradient	
1043		CSR min 0.000 max 0.000 mean 0.000	1117	GPU 64 COO min 4.810 max 4.930 mean 4.869
1044		H min 7.205 max 7.205 mean 7.205	1118	CSR min 4.820 max 6.460 mean 6.208
1045	Row-Premute		1119	H min 10.554 max*10.661 mean 10.638
1046		GPU 64 COO min 3.800 max 3.940 mean 3.875	1120 Row-Column-Permute	
1047		CSR min 3.710 max 4.570 mean 4.399	1121	GPU 64 COO min 4.810 max 4.940 mean 4.864
1048		H min 11.025 max 11.031 mean 11.028	1122	CSR min 5.930 max 6.520 mean 6.379
1049	Row-Gradient		1123	H min 10.041 max 10.047 mean 10.044
1050		GPU 64 COO min 3.800 max* 4.120 mean 3.962	1124 cvxqp3.mtx	
1051 1052		CSR min 4.340 max* 4.670 mean 4.546 H min 10.296 max 10.307 mean 10.300	1125 Regular	GPU 64 COO min 3.350 max* 3.590 mean 3.483
1052	Column-Gradient	n IIIIn 10.296 IIIax 10.307 IIIean 10.300	1126 1127	CSR min 5.430 max* 9.260 mean 8.333
1054	column oradient	GPU 64 COO min 3.880 max 4.100 mean 3.978	1128	H min 8.646 max 8.646 mean 8.646
1055		CSR min 4.240 max 4.570 mean 4.412	1129 Row-Premute	
1056		H min 10.881 max 10.886 mean 10.883	1130	GPU 64 COO min 3.230 max 3.480 mean 3.371
1057	Row-Column-Permute		1131	CSR min 7.560 max 8.220 mean 7.900
1058		GPU 64 COO min 3.800 max 3.980 mean 3.885	1132	H min 11.027 max 11.033 mean 11.030
1059		CSR min 4.130 max 4.540 mean 4.399	1133 Row-Gradient	
1060		H min 11.025 max*11.033 mean 11.029	1134	GPU 64 COO min 3.240 max 3.510 mean 3.396
1061	brainpc2.mtx		1135	CSR min 6.990 max 7.890 mean 7.574
1062	Regular		1136	H min 11.060 max 11.069 mean 11.064
1063		GPU 64 COO min 0.000 max 0.000 mean 0.000	1137 Column-Gradient	
1064		CSR min 0.000 max 0.000 mean 0.000	1138	GPU 64 COO min 3.240 max 3.480 mean 3.374
1065		H min 7.478 max 7.478 mean 7.478	1139	CSR min 6.980 max 7.900 mean 7.557
1066 1067	Row-Premute	GPU 64 COO min 3.840 max* 6.750 mean 4.110	1140 1141 Row-Column-Permute	H min 11.126 max*11.134 mean 11.130
1068		CSR min 4.260 max* 4.500 mean 4.437	1142	GPU 64 COO min 3.110 max 3.470 mean 3.365
1069		H min 9.809 max 9.813 mean 9.811	1143	CSR min 4.810 max 8.210 mean 7.742
1070	Row-Gradient		1144	H min 11.026 max 11.032 mean 11.030
1071		GPU 64 COO min 0.640 max 4.030 mean 3.864	1145 ex19.mtx	
1072		CSR min 4.270 max 4.470 mean 4.383	1146 Regular	
1073		H min 9.722 max 9.727 mean 9.724	1147	GPU 64 COO min 2.450 max* 2.610 mean 2.564
1074	Column-Gradient		1148	CSR min 4.490 max 4.760 mean 4.714
1075		GPU 64 COO min 0.640 max 4.070 mean 3.898	1149	H min 8.228 max 8.228 mean 8.228
1076		CSR min 4.230 max 4.500 mean 4.386	1150 Row-Premute	
1077		H min 10.368 max*10.372 mean 10.370	1151	GPU 64 COO min 2.000 max 2.040 mean 2.021
1078	Row-Column-Permute		1152	CSR min 4.640 max 4.780 mean 4.733
1079		GPU 64 COO min 3.980 max 4.110 mean 4.027 CSR min 4.320 max 4.490 mean 4.437	1153	H min 11.835 max 11.840 mean 11.838
1080 1081		H min 9.809 max 9.813 mean 9.811	1154 Row-Gradient 1155	GPU 64 COO min 2.240 max 2.390 mean 2.329
1082	c-47.mtx	11 1111 3.003 max 3.013 mean 3.011	1156	CSR min 4.570 max* 4.850 mean 4.807
1083	Regular		1157	H min 10.742 max 10.752 mean 10.747
1084	•	GPU 64 COO min 3.980 max* 4.080 mean 4.026	1158 Column-Gradient	
1085		CSR min 4.760 max 4.850 mean 4.812	1159	GPU 64 COO min 2.010 max 2.050 mean 2.034
1086		H min 8.364 max 8.364 mean 8.364	1160	CSR min 4.570 max 4.760 mean 4.701
1087	Row-Premute		1161	H min 11.872 max*11.881 mean 11.878
1088		GPU 64 COO min 3.880 max 4.010 mean 3.942	1162 Row-Column-Permute	
1089		CSR min 4.040 max 4.900 mean 4.807	1163	GPU 64 COO min 2.000 max 2.040 mean 2.023
1090		H min 10.059 max 10.063 mean 10.061	1164	CSR min 0.770 max 4.780 mean 4.594
1091	Row-Gradient		1165	H min 11.835 max 11.840 mean 11.838
1092		GPU 64 COO min 3.900 max 4.050 mean 3.976	1166 gen4.mtx	
1093 1094		CSR min 4.380 max 4.740 mean 4.630 H min 10.201 max 10.228 mean 10.214	1167 Regular 1168	GPU 64 COO min 4.880 max 4.980 mean 4.900
1095	Column-Gradient	11 IIII 10.201 IIIAX 10.220 IIICAN 10.214	1169	CSR min 10.020 max*11.300 mean 10.716
1096		GPU 64 COO min 3.860 max 3.990 mean 3.936	1170	H min 9.234 max 9.234 mean 9.234
1097		CSR min 4.350 max 4.610 mean 4.525	1171 Row-Premute	
1098		H min 11.204 max*11.241 mean 11.222	1172	GPU 64 COO min 4.860 max 4.930 mean 4.890
1099	Row-Column-Permute		1173	CSR min 0.330 max 11.200 mean 10.038
1100		GPU 64 COO min 3.890 max 4.020 mean 3.953	1174	H min 10.249 max 10.254 mean 10.252
1101		CSR min 4.490 max* 4.920 mean 4.840	1175 Row-Gradient	
1102		H min 10.058 max 10.063 mean 10.061	1176	GPU 64 COO min 4.860 max* 4.990 mean 4.908
1103	case9.mtx		1177	CSR min 9.160 max 11.240 mean 10.435
1104	Regular		1178	H min 9.939 max 9.961 mean 9.947
1105 1106		GPU 64 COO min 0.000 max 0.000 mean 0.000	1179 Column-Gradient 1180	CDII 64 COO = i = 4 700 = · · · · · · · · · · · · · · · · · ·
1100		CSR min 0.000 max 0.000 mean 0.000	1100	GPU 64 COO min 4.780 max 4.880 mean 4.816

1101		CSR min 7.770 max 10.570 mean 9.407	1355 Day Descrite	
1181 1182		H min 10.851 max*10.876 mean 10.864	1255 Row-Premute 1256	GPU 64 COO min 4.420 max 4.520 mean 4.445
1183	Row-Column-Permute	11 IIII 10.631 IIIAX^10.670 IIIEAII 10.604	1257	CSR min 10.520 max 10.880 mean 10.696
1184	NOW-COIUMIN-FEI MULE	GPU 64 COO min 4.850 max 4.950 mean 4.886	1258	H min 10.960 max*10.968 mean 10.963
1185		CSR min 10.220 max 11.280 mean 10.748	1259 Row-Gradient	11 IIII 10.500 IIIAX^10.500 IIIEAI 10.503
1186		H min 10.250 max 10.255 mean 10.252	1260	GPU 64 COO min 4.570 max 4.690 mean 4.605
1187	lp_fit2d.mtx	11 IIII11 10.230 IIIAX 10.233 IIIEAII 10.232	1261	CSR min 4.550 max 13.350 mean 12.479
1188	Regular		1262	H min 9.508 max 9.527 mean 9.520
1189	regular	GPU 64 COO min 4.360 max* 4.640 mean 4.515	1263 Column-Gradient	11 IIII 3.300 IIIAX 3.327 IIICAN 3.320
1190		CSR min 10.080 max 10.900 mean 10.491	1264	GPU 64 COO min 4.430 max 4.530 mean 4.461
1191		H min 11.109 max 11.109 mean 11.109	1265	CSR min 10.250 max 10.940 mean 10.603
1192	Row-Premute	11 IIII 11.105 IIIAX 11.105 IIIEAN 11.105	1266	H min 10.934 max 10.945 mean 10.939
1193	NOW-F1 ellique	GPU 64 COO min 4.170 max 4.630 mean 4.476	1267 Row-Column-Permute	11 IIII 10.534 IIIAX 10.545 IIIEAN 10.535
1194		CSR min 0.910 max 10.910 mean 10.257	1268	GPU 64 COO min 4.420 max 4.520 mean 4.450
1195		H min 11.098 max 11.104 mean 11.101	1269	CSR min 7.380 max 10.900 mean 10.598
1196	Row-Gradient	11 IIII 11.030 IIIAX 11.104 IIIEAN 11.101	1270	H min 10.959 max 10.967 mean 10.963
1197	Now-Grauterit	GPU 64 COO min 4.370 max 4.630 mean 4.529	1271 mult_dcop_01.mtx	11 IIII1 10.535 IIIAX 10.507 IIIEAN 10.503
1198		CSR min 10.030 max 10.970 mean 10.624	1272 Regular	
1199		H min 11.109 max 11.109 mean 11.109	1272 Regulai 1273	GPU 64 COO min 3.420 max 3.630 mean 3.555
1200	Column-Gradient	11 IIII 11.105 IIIAX 11.105 IIIEAN 11.105	1273	CSR min 3.650 max 4.090 mean 3.814
1200	COTUMNI-OF AUTERIC	GPU 64 COO min 4.250 max 4.640 mean 4.499	1275	H min 9.689 max 9.689 mean 9.689
1201		CSR min 8.510 max*11.010 mean 10.505	1276 Row-Premute	11 IIII 9.009 IIIAX 9.009 IIIEAII 9.009
1203		H min 11.328 max*11.333 mean 11.331	1277	GPU 64 COO min 3.450 max 3.580 mean 3.521
1204	Row-Column-Permute	11 IIII 11.520 IIIAX*11.555 IIIEAII 11.551	1278	CSR min 3.610 max 4.150 mean 3.785
1205	Now Column Termate	GPU 64 COO min 4.350 max 4.640 mean 4.511	1279	H min 10.738 max 10.742 mean 10.740
1206		CSR min 10.040 max 10.790 mean 10.468	1280 Row-Gradient	11 IIII 10.750 IIIAX 10.742 IIICAN 10.740
1207		H min 11.097 max 11.106 mean 11.101	1281	GPU 64 COO min 3.510 max* 3.660 mean 3.579
1207	lp_osa_07.mtx	II IIIII II.037 IIIAX II.100 IIIEAII II.101	1282	CSR min 3.650 max 4.160 mean 3.806
1209	Regular		1283	H min 10.576 max 10.585 mean 10.580
1210	кевита	GPU 64 COO min 0.460 max* 3.640 mean 3.456	1284 Column-Gradient	11 IIII 10.370 IIIAX 10.363 IIIEAN 10.360
1211		CSR min 5.570 max* 8.530 mean 8.106	1285	GPU 64 COO min 3.460 max 3.650 mean 3.584
1211		H min 8.412 max 8.412 mean 8.412	1286	CSR min 3.660 max* 4.240 mean 3.799
1213	Row-Premute	11 IIII11 0.412 IIIdx 0.412 IIIedii 0.412	1287	H min 10.826 max*10.842 mean 10.836
1214	NOW IT CHILD'E	GPU 64 COO min 3.140 max 3.450 mean 3.367	1288 Row-Column-Permute	11 III 10.020 IIIAX*10.042 IIICAN 10.030
1215		CSR min 7.600 max 8.070 mean 7.853	1289	GPU 64 COO min 3.470 max 3.580 mean 3.532
1216		H min 9.255 max 9.258 mean 9.256	1290	CSR min 3.600 max 3.980 mean 3.743
1217	Row-Gradient	11 IIII 5.255 IIIAX 5.256 IIIEAII 5.256	1291	H min 10.738 max 10.742 mean 10.740
1218	NOW OF BUTCHE	GPU 64 COO min 3.190 max 3.610 mean 3.509	1292 mult_dcop_02.mtx	11 IIII 10.750 IIIAX 10.742 IIICAN 10.740
1219		CSR min 0.000 max 8.260 mean 7.597	1293 Regular	
1220		H min 8.583 max 8.678 mean 8.670	1294 Regulai	GPU 64 COO min 3.390 max 3.660 mean 3.585
1221	Column-Gradient	11 1111 0.303 max 0.076 mean 0.076	1295	CSR min 0.960 max 4.330 mean 4.162
1222	COTUMNI-OF AUTERIC	GPU 64 COO min 3.330 max 3.500 mean 3.416	1296	H min 9.689 max 9.689 mean 9.689
1223		CSR min 6.730 max 7.540 mean 7.199	1297 Row-Premute	11 IIII 9.009 IIIAX 9.009 IIIEAII 9.009
1224		H min 9.542 max* 9.604 mean 9.581	1298	GPU 64 COO min 3.310 max 3.600 mean 3.488
1225	Row-Column-Permute	11 1111 3.342 max* 3.004 mean 3.301	1299	CSR min 0.620 max 4.290 mean 4.132
1226	NOW-COIUMIN-FEI MULE	GPU 64 COO min 3.290 max 3.430 mean 3.365	1300	H min 10.738 max 10.743 mean 10.740
1227		CSR min 7.390 max 8.060 mean 7.832	1301 Row-Gradient	11 IIII 10.750 IIIAX 10.745 IIICAN 10.740
1228		H min 9.255 max 9.258 mean 9.256	1302	GPU 64 COO min 3.310 max* 3.670 mean 3.593
1229	Maragal_6.mtx		1303	CSR min 4.130 max* 4.430 mean 4.331
1230	Regular		1304	H min 10.576 max 10.584 mean 10.580
1231		GPU 64 COO min 4.160 max 4.310 mean 4.217	1305 Column-Gradient	
1232		CSR min 4.940 max 4.960 mean 4.956	1306	GPU 64 COO min 0.550 max 3.660 mean 3.486
1233		H min 9.930 max 9.930 mean 9.930	1307	CSR min 3.890 max 4.410 mean 4.275
1234	Row-Premute		1308	H min 10.831 max*10.843 mean 10.836
1235		GPU 64 COO min 4.220 max 4.240 mean 4.225	1309 Row-Column-Permute	
1236		CSR min 4.750 max*13.040 mean 5.133	1310	GPU 64 COO min 3.470 max 3.590 mean 3.542
1237		H min 10.776 max 10.778 mean 10.777	1311	CSR min 4.190 max 4.290 mean 4.242
1238	Row-Gradient		1312	H min 10.738 max 10.742 mean 10.740
1239		GPU 64 COO min 4.180 max* 4.450 mean 4.245	1313 mult_dcop_03.mtx	
1240		CSR min 4.880 max 4.940 mean 4.915	1314 Regular	
1241		H min 11.259 max*11.302 mean 11.281	1315	GPU 64 COO min 3.360 max* 3.660 mean 3.550
1242	Column-Gradient		1316	CSR min 3.650 max 4.090 mean 3.813
1243		GPU 64 COO min 4.200 max 4.250 mean 4.236	1317	H min 9.689 max 9.689 mean 9.689
1244		CSR min 4.800 max 4.890 mean 4.859	1318 Row-Premute	
1245		H min 12.022 max 12.073 mean 12.051	1319	GPU 64 COO min 3.450 max 3.580 mean 3.521
1246	Row-Column-Permute		1320	CSR min 3.610 max 4.160 mean 3.784
1247		GPU 64 COO min 4.210 max 4.230 mean 4.222	1321	H min 10.738 max 10.743 mean 10.740
1248		CSR min 4.860 max 4.890 mean 4.887	1322 Row-Gradient	10.770
		H min 10.776 max 10.778 mean 10.778	1323	GPU 64 COO min 3.470 max 3.660 mean 3.572
1249			1324	CSR min 3.640 max 4.190 mean 3.809
	mhd4800a.mt×			
1250	mhd4800a.mtx Regular			
1250 1251	mhd4800a.mtx Regular	GPU 64 COO min 4.570 max* 4.710 mean 4.608	1325	
1250 1251 1252		GPU 64 COO min 4.570 max* 4.710 mean 4.608 CSR min 12.690 max*13.940 mean 13.369	1325 1326 Column-Gradient	H min 10.572 max 10.584 mean 10.580
1250 1251		GPU 64 COO min 4.570 max* 4.710 mean 4.608 CSR min 12.690 max*13.940 mean 13.369 H min 7.132 max 7.132 mean 7.132	1325	

1329		H mi	in 10.828 max*10.840 mean	10.834	1403		GPU 64 COO min	4.540 max 4.940 mean 4.874
1330	Row-Column-Permute				1404		CSR min	6.280 max 6.520 mean 6.403
1331		GPU 64 COO mi	in 3.370 max 3.610 mean		1405			10.042 max 10.047 mean 10.044
1332			in 3.610 max 3.970 mean		1406	Row-Gradient		
1333			in 10.738 max 10.741 mean		1407		GPU 64 COO min	4.830 max 4.930 mean 4.875
1334	OPF_3754.mtx				1408			5.790 max* 6.560 mean 6.289
1335	Regular				1409			9.675 max 9.706 mean 9.692
1336	8	GPU 64 COO mi	in 4.700 max* 4.930 mean		1410	Column-Gradient		
1337		CSR mi	in 6.230 max* 6.600 mean	6.411	1411		GPU 64 COO min	4.790 max* 4.960 mean 4.880
1338			in 8.393 max 8.393 mean		1412			5.760 max 6.450 mean 6.204
1339	Row-Premute				1413			10.601 max*10.661 mean 10.626
1340	Now 11 cmacc	GPII 64 COO mi	in 4.620 max 4.890 mean		1414	Row-Column-Permute		TO: SOT MAX TO: SOT MEAN TO: SES
1341			in 5.780 max 6.310 mean		1415	Now Column Termace	CPII 64 COO min	4.330 max 4.950 mean 4.845
1342			in 11.265 max 11.272 mean		1416			5.740 max 6.500 mean 6.375
	Row-Gradient		tii 11.205 max 11.272 mean		1417			10.041 max 10.046 mean 10.044
1343 1344	NOW-GI addelle	CDU 64 COO	in 4.570 max 4.870 mean			TCODE DC 1-20 -71	11 111211	10.041 max 10.040 mean 10.044
			in 5.770 max 4.870 mean		1419	TSOPF_RS_b39_c7.mtx Regular		
1345						Regutar	CDU 54 COO	4.300 max* 4.430 mean 4.364
1346	0.1	H M1	in 10.464 max 10.473 mean		1420			
1347	Column-Gradient				1421			4.480 max 4.750 mean 4.716
1348			in 4.580 max 4.870 mean		1422		H min	7.304 max 7.304 mean 7.304
1349			in 5.630 max 6.180 mean		1423	Row-Premute		
1350		H mi	in 11.394 max*11.401 mean		1424			4.260 max 4.400 mean 4.353
1351	Row-Column-Permute				1425			4.490 max 4.770 mean 4.734
1352			in 4.610 max 4.900 mean		1426		H min	10.536 max 10.541 mean 10.539
1353			in 5.010 max 6.300 mean		1427	Row-Gradient		
1354		H mi	in 11.268 max 11.272 mean	11.270	1428			3.970 max 4.420 mean 4.338
1355	OPF_6000.mtx				1429		CSR min	4.620 max* 4.820 mean 4.789
1356	Regular				1430		H min	9.638 max 9.644 mean 9.641
1357			in 3.780 max* 3.920 mean		1431	Column-Gradient		
1358		CSR mi	in 4.270 max 4.360 mean	4.332	1432		GPU 64 COO min	4.240 max 4.430 mean 4.368
1359		H mi	in 8.799 max 8.799 mean	8.799	1433		CSR min	4.710 max 4.770 mean 4.736
1360	Row-Premute				1434		H min	11.129 max*11.222 mean 11.205
1361		GPU 64 COO mi	in 3.770 max 3.870 mean	3.821	1435	Row-Column-Permute		
1362		CSR mi	in 3.970 max*11.050 mean	4.439	1436		GPU 64 COO min	4.260 max 4.410 mean 4.359
1363		H mi	in 11.872 max 11.877 mean	11.875	1437		CSR min	4.660 max 4.760 mean 4.738
1364	Row-Gradient				1438		H min	10.537 max 10.541 mean 10.539
1365		GPU 64 COO mi	in 3.700 max 3.870 mean	3.795				
1366		CSR mi	in 4.330 max 4.440 mean					
1366 1367			in 4.330 max 4.440 mean in 11.109 max 11.116 mean	4.403 11.113		11 FIII		
	Column-Gradient			4.403 11.113	1439	11 FIJI		
1367	Column-Gradient	H mi		4.403 111.113		-		
1367 1368	Column-Gradient	H mi	in 11.109 max 11.116 mean	4.403 111.113 1 3.804		mult_dcop_03.mtx		
1367 1368 1369	Column-Gradient	H mi GPU 64 COO mi CSR mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean	4.403 111.113 1 3.804 1 4.308	1440	-	GPU 64 COO min	5.140 max* 5.140 mean 5.140
1367 1368 1369 1370	Column-Gradient Row-Column-Permute	H mi GPU 64 COO mi CSR mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean	4.403 111.113 1.3.804 1.4.308 1.12.043	1440 r	mult_dcop_03.mtx		5.140 max* 5.140 mean 5.140 10.340 max*10.390 mean 10.365
1367 1368 1369 1370 1371		H mi GPU 64 COO mi CSR mi H mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean	4.403 111.113 13.804 14.308 112.043	1440 r 1441 1442	mult_dcop_03.mtx	CSR min	10.340 max*10.390 mean 10.365
1367 1368 1369 1370 1371 1372 1373		H mi GPU 64 COO mi CSR mi H mi GPU 64 COO mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 3.780 max 3.860 mean	4.403 111.113 13.804 14.308 12.043	1440 r 1441 1442 1443 1444	mult_dcop_03.mtx Regular	CSR min	
1367 1368 1369 1370 1371 1372 1373 1374		H mi GPU 64 COO mi CSR mi H mi GPU 64 COO mi CSR mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean	1 4.403 111.113 1 3.804 4.308 12.043 1 3.819 4.259	1440 1 1441 1 1442 1 1443 1 1444 1 1445	mult_dcop_03.mtx	CSR min H min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689
1367 1368 1369 1370 1371 1372 1373		H mi GPU 64 COO mi CSR mi H mi GPU 64 COO mi CSR mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 3.780 max 3.860 mean	1 4.403 111.113 1 3.804 4 .308 12.043 1 3.819 1 4.259 1 11.876	1440 r 1441 1442 1443 1444	mult_dcop_03.mtx Regular	CSR min H min GPU 64 COO min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980
1367 1368 1369 1370 1371 1372 1373 1374 1375	Row-Column-Permute	H mi GPU 64 COO mi CSR mi H mi GPU 64 COO mi CSR mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean	1 4.403 111.113 1 3.804 1 4.308 1 12.043 1 3.819 1 4.259 1 11.876	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1	mult_dcop_03.mtx Regular	CSR min H min GPU 64 COO min CSR min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 9.425
1367 1368 1369 1370 1371 1372 1373 1374 1375 1376	Row-Column-Permute	H mi GPU 64 COO mi CSR mi H mi GPU 64 COO mi CSR mi H mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean	4.403 111.113 13.804 14.308 12.043 13.819 14.259 111.876	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448	mult_dcop_03.mtx Regular Row-Premute	CSR min H min GPU 64 COO min CSR min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980
1367 1368 1369 1370 1371 1372 1373 1374 1375 1376	Row-Column-Permute	H mi GPU 64 COO mi GPU 64 COO mi GPU 64 COO mi CSR mi H mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean	1 4.403 111.113 1 3.804 1 4.308 1 12.043 1 3.819 1 4.259 1 11.876	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448 1 1449	mult_dcop_03.mtx Regular	CSR min H min GPU 64 COO min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 9.425 10.739 max 10.739 mean 10.739
1367 1368 1369 1370 1371 1372 1373 1374 1375 1376 1377	Row-Column-Permute	H mi GPU 64 COO mi H mi GPU 64 COO mi CSR mi H mi GPU 64 COO mi GPU 64 COO mi CSR mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 2.920 max* 3.140 mean	1 4.403 111.113 1 3.804 1 4.308 1 12.043 1 3.819 1 4.259 1 11.876	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448	mult_dcop_03.mtx Regular Row-Premute	GPU 64 COO min GPU 64 COO min GPU 64 COO min GPU 64 COO min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 9.425 10.739 max 10.739 mean 10.739 5.080 max 5.090 mean 5.085
1367 1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378	Row-Column-Permute	H mi GPU 64 COO mi H mi GPU 64 COO mi CSR mi H mi GPU 64 COO mi GPU 64 COO mi CSR mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 2.920 max* 3.140 mean in 5.550 max 5.980 mean	4.403 111.113 1.3.804 1.4.308 1.2.043 1.3.819 1.4.259 1.1.876	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448 1 1449 1 1450 1 1451 1	mult_dcop_03.mtx Regular Row-Premute	GPU 64 COO min CSR min H min CSR min GPU 64 COO min CSR min GPU 64 COO min CSR min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 9.425 10.739 max 10.739 mean 10.739
1367 1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380	Row-Column-Permute shermanACb.mtx Regular	H mi GPU 64 COO mi GPU 64 COO mi CSR mi H mi GPU 64 COO mi GPU 64 COO mi H mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean in 11.877 mean in 2.920 max* 3.140 mean in 5.550 max 5.980 mean in 8.600 max 8.600 mean	1 4.403 111.113 1 3.804 1 4.308 1 12.043 1 3.819 1 4.259 1 11.876	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448 1 1449 1 1450 1 1451 1 1452	mult_dcop_03.mtx Regular Row-Premute Row-Gradient	GPU 64 COO min CSR min GPU 64 COO min CSR min GPU 64 COO min CSR min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 10.739 10.739 max 10.739 mean 10.739 5.080 max 5.090 mean 5.085 9.720 max 10.300 mean 10.010
1367 1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381	Row-Column-Permute shermanACb.mtx Regular	H mi GPU 64 COO mi CSR mi H mi GPU 64 COO mi CSR mi H mi GPU 64 COO mi CSR mi H mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 2.920 max* 3.140 mean in 5.550 max 5.980 mean in 8.600 max 8.600 mean in 2.760 max 3.020 mean	1. 4.403 1.11.113 1. 3.804 1. 4.308 1. 12.043 1. 3.819 1. 4.259 1. 11.876 1. 3.048 1. 5.803 1. 8.600	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448 1 1449 1 1450 1 1451 1 1452 1 1453 1	mult_dcop_03.mtx Regular Row-Premute	CSR min H min GPU 64 COO min CSR min H min GPU 64 COO min CSR min H min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 10.739 10.739 max 10.739 mean 10.739 5.080 max 5.090 mean 5.085 9.720 max 10.300 mean 10.010 10.579 max 10.582 mean 10.588
1367 1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381 1382	Row-Column-Permute shermanACb.mtx Regular	H mi GPU 64 COO mi H mi GPU 64 COO mi CSR mi H mi GPU 64 COO mi CSR mi H mi GPU 64 COO mi CSR mi CSR mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 2.920 max* 3.140 mean in 5.550 max 5.980 mean in 8.600 max 8.600 mean in 2.760 max 3.020 mean in 2.760 max 3.020 mean in 2.760 max 3.020 mean	1 4.403 1 11.113 1 3.804 1 4.308 1 12.043 1 3.819 1 1.876 1 3.048 1 5.803 1 8.600 1 2.898 1 5.632	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448 1 1450 1 1451 1 1452 1 1453 1 1454 1	mult_dcop_03.mtx Regular Row-Premute Row-Gradient	CSR min H cPU 64 COO min CSR min H min CPU 64 COO min CSR min H min GPU 64 COO min CSR min GPU 64 COO min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 10.739 5.080 max 5.090 mean 10.010 10.579 max 10.582 mean 10.588 5.030 max 5.120 mean 5.075
1367 1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381 1382 1383	Row-Column-Permute shermanACb.mtx Regular Row-Premute	H mi GPU 64 COO mi H mi GPU 64 COO mi CSR mi H mi GPU 64 COO mi CSR mi H mi GPU 64 COO mi CSR mi CSR mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 2.920 max* 3.140 mean in 5.550 max 5.980 mean in 8.600 max 8.600 mean in 2.760 max 3.020 mean	1 4.403 1 11.113 1 3.804 1 4.308 1 12.043 1 3.819 1 4.259 1 11.876 1 3.048 1 5.803 1 8.600 1 2.898 1 5.632 1 10.379	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448 1 1450 1 1451 1 1452 1 1453 1 1454 1 1455 1	mult_dcop_03.mtx Regular Row-Premute Row-Gradient	CSR min H min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 10.739 5.080 max 5.090 mean 5.085 9.720 max 10.390 mean 10.10 10.579 max 10.582 mean 10.580 5.030 max 5.120 mean 5.075 9.330 max 9.770 mean 9.550
1367 1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381 1382 1383 1384	Row-Column-Permute shermanACb.mtx Regular	H mi GPU 64 COO mi CSR mi H mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 2.920 max* 3.140 mean in 5.550 max 5.980 mean in 8.600 max 8.600 mean in 2.660 max 3.020 mean in 12.660 max 5.830 mean in 10.377 max 10.381 mean	1 4.403 1 11.113 1 3.804 1 4.308 1 12.043 1 3.819 1 4.259 1 11.876 1 3.048 1 5.803 1 8.600 1 2.898 1 5.632 1 10.379	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448 1 1450 1 1451 1 1453 1 1454 1 1455 1 1456 1	mult_dcop_03.mtx Regular Row-Premute Row-Gradient Column-Gradient	CSR min H min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 10.739 5.080 max 5.090 mean 10.010 10.579 max 10.582 mean 10.588 5.030 max 5.120 mean 5.075
1367 1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381 1382 1383 1383	Row-Column-Permute shermanACb.mtx Regular Row-Premute	H mi GPU 64 COO mi CSR mi H mi CSR mi H mi GPU 64 COO mi CSR mi H mi GPU 64 COO mi CSR mi H mi GPU 64 COO mi CSR mi GPU 64 COO mi CSR mi GPU 64 COO mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 12.041 max*2.045 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 2.920 max* 3.140 mean in 5.550 max 5.980 mean in 8.600 max 8.600 mean in 2.760 max 3.020 mean in 10.377 max 10.381 mean in 2.800 max 3.040 mean	1. 4.403 1. 11.113 1. 3.804 1. 4.308 1. 12.043 1. 3.819 1. 4.259 1. 11.876 1. 3.048 1. 5.803 1. 8.600 1. 2.898 1. 5.632 1. 6.379 1. 6.379	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448 1 1450 1 1451 1 1452 1 1453 1 1454 1 1455 1 1456 1 1457 1	mult_dcop_03.mtx Regular Row-Premute Row-Gradient	CSR min H min GPU 64 COO min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 10.739 5.080 max 10.739 mean 10.739 5.080 max 5.090 mean 5.085 9.720 max 10.300 mean 10.100 10.579 max 10.582 mean 10.580 5.030 max 5.120 mean 5.075 9.330 max 9.770 mean 9.550 10.835 max*10.838 mean 10.836
1367 1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381 1382 1383 1384 1385 1386	Row-Column-Permute shermanACb.mtx Regular Row-Premute	H mi GPU 64 COO mi H mi GPU 64 COO mi CSR mi GPU 64 COO mi CSR mi CSR mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 2.920 max* 3.140 mean in 5.550 max 5.980 mean in 8.600 max 8.600 mean in 2.760 max 3.020 mean in 10.377 max 10.381 mean in 2.800 max 3.040 mean in 2.800 max 3.040 mean in 5.330 max* 6.020 mean	1 4.403 1 11.113 1 3.804 1 4.308 1 12.043 1 3.819 1 4.259 1 11.876 1 3.048 1 5.803 1 8.600 1 2.898 1 5.632 1 10.379	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448 1 1449 1 1450 1 1451 1 1452 1 1453 1 1454 1 1455 1 1455 1 1456 1 1457 1 1458 1	mult_dcop_03.mtx Regular Row-Premute Row-Gradient Column-Gradient	CSR min H min GPU 64 COO min GPU 64 COO min GPU 64 COO min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 10.739 mean 10.739 mean 10.739 mean 10.739 mean 10.739 mean 10.580 9.720 max 10.582 mean 10.580 5.030 max 5.120 mean 5.085 9.330 max 9.770 mean 9.550 10.835 max*10.838 mean 10.836 5.000 max 5.010 mean 5.005
1367 1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1387 1381 1382 1383 1384 1385 1386 1387	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient	H mi GPU 64 COO mi H mi GPU 64 COO mi CSR mi GPU 64 COO mi CSR mi CSR mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 12.041 max*2.045 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 2.920 max* 3.140 mean in 5.550 max 5.980 mean in 8.600 max 8.600 mean in 2.760 max 3.020 mean in 10.377 max 10.381 mean in 2.800 max 3.040 mean	1 4.403 1 11.113 1 3.804 1 4.308 1 12.043 1 3.819 1 4.259 1 11.876 1 5.803 1 8.600 1 2.898 1 5.632 1 10.379 1 2.944 1 5.742 1 9.922	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448 1 1450 1 1451 1 1452 1 1453 1 1454 1 1455 1 1456 1 1457 1 1458 1 1459 1	mult_dcop_03.mtx Regular Row-Premute Row-Gradient Column-Gradient	CSR min H min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 9.425 10.739 max 10.739 mean 10.739 5.080 max 5.090 mean 10.010 10.579 max 10.582 mean 10.580 5.030 max 5.120 mean 5.075 9.330 max 9.770 mean 9.550 10.835 max*10.838 mean 10.836 5.000 max 5.010 mean 5.005 7.580 max 5.010 mean 5.005
1367 1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1381 1381 1382 1383 1384 1385 1386 1387 1388	Row-Column-Permute shermanACb.mtx Regular Row-Premute	H mi GPU 64 COO mi GPU 64 COO mi CSR mi H mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 12.041 max*2.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 2.920 max* 3.140 mean in 5.550 max 5.980 mean in 2.760 max 8.600 mean in 2.760 max 10.381 mean in 2.800 max 3.020 mean in 2.800 max 3.020 mean in 2.800 max 9.925 mean	1 4.403 1 11.113 1 3.804 1 4.308 1 12.043 1 3.819 1 4.259 1 11.876 1 3.048 1 5.803 1 8.600 1 2.898 1 5.632 1 10.379 1 2.944 1 5.742 1 9.922	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448 1 1450 1 1451 1 1452 1 1453 1 1454 1 1455 1 1456 1 1457 1 1458 1 1459 1 1460	mult_dcop_03.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute	CSR min H min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 10.739 mean 10.739 mean 10.739 mean 10.739 mean 10.739 mean 10.580 9.720 max 10.582 mean 10.580 5.030 max 5.120 mean 5.085 9.330 max 9.770 mean 9.550 10.835 max*10.838 mean 10.836 5.000 max 5.010 mean 5.005
1367 1368 1369 1370 1371 1372 1373 1375 1376 1377 1378 1380 1381 1382 1383 1384 1385 1386 1387 1388 1388 1388	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient	H mi GPU 64 COO mi H mi CSR mi H mi GPU 64 COO mi CSR mi GPU 64 COO mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 12.041 max*2.045 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 2.920 max* 3.140 mean in 5.550 max 5.980 mean in 2.760 max 3.020 mean in 10.377 max 10.381 mean in 2.800 max 3.040 mean in 5.330 max* 6.020 mean in 9.919 max 9.925 mean in 2.720 max 3.010 mean	1. 4.403 1. 11.113 1. 3.804 1. 4.308 1. 12.043 1. 3.819 1. 4.259 1. 11.876 1. 3.048 1. 5.803 1. 8.600 1. 2.898 1. 5.632 1. 3.79 1. 3.	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1450 1 1451 1 1452 1 1453 1 1454 1 1455 1 1456 1 1457 1 1458 1 1459 1 1460 1 1461 1	mult_dcop_03.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute	CSR min H min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 9.425 10.739 max 10.739 mean 10.739 5.080 max 5.090 mean 10.010 10.579 max 10.582 mean 10.580 5.030 max 5.120 mean 5.075 9.330 max 9.770 mean 9.550 10.835 max*10.838 mean 10.836 5.000 max 5.010 mean 5.005 7.580 max 5.010 mean 5.005
1367 1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1378 1381 1381 1382 1383 1384 1385 1386 1387 1388 1388 1389 1390	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient	H mi GPU 64 COO mi H mi GPU 64 COO mi CSR mi CSR mi GPU 64 COO mi CSR mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 12.041 max*12.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 2.920 max* 3.140 mean in 5.550 max 5.980 mean in 6.600 max 8.600 mean in 2.760 max 3.020 mean in 10.377 max 10.381 mean in 2.800 max 3.040 mean in 5.330 max* 6.020 mean in 9.919 max 9.925 mean in 2.720 max 3.010 mean in 0.000 max 5.840 mean	1. 4.403 1. 11.113 1. 3.804 1. 4.308 1. 12.043 1. 3.819 1. 4.259 1. 1.876 1. 3.048 1. 5.803 1. 8.600 1. 2.898 1. 5.632 1. 10.379 1. 2.944 1. 5.742 1. 9.922 1. 2.926 1. 5.513	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448 1 1450 1 1451 1 1452 1 1453 1 1454 1 1455 1 1456 1 1457 1 1458 1 1450 1 1461 1 1461 1	mult_dcop_03.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute	CSR min H min GPU 64 COO min CSR min H min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 10.739 5.080 max 5.090 mean 10.739 5.080 max 10.739 mean 10.101 10.579 max 10.582 mean 10.580 5.030 max 5.120 mean 5.075 9.330 max 9.770 mean 9.550 10.835 max*10.838 mean 10.836 5.000 max 5.010 mean 5.005 7.580 max 9.460 mean 8.520 10.739 max 10.741 mean 10.740
1367 1368 1369 1370 1371 1372 1373 1374 1375 1376 1377 1380 1381 1382 1383 1384 1385 1386 1387 1388 1388 1388 1388 1389	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient Column-Gradient	H mi GPU 64 COO mi H mi GPU 64 COO mi CSR mi CSR mi GPU 64 COO mi CSR mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 12.041 max*2.045 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 2.920 max* 3.140 mean in 5.550 max 5.980 mean in 2.760 max 3.020 mean in 10.377 max 10.381 mean in 2.800 max 3.040 mean in 5.330 max* 6.020 mean in 9.919 max 9.925 mean in 2.720 max 3.010 mean	1 4.403 1 11.113 1 3.804 1 4.308 1 12.043 1 3.819 1 4.259 1 11.876 1 3.048 1 5.803 1 8.600 1 2.898 1 5.632 1 10.379 1 2.944 1 5.742 1 9.922 1 2.926 1 5.513 1 10.591	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448 1 1450 1 1451 1 1452 1 1453 1 1456 1 1457 1 1458 1 1459 1 1460 1 1461 1 1462 1 1463 1	mult_dcop_03.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute	CSR min H GPU 64 COO min CSR min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 9.425 10.739 max 10.739 mean 10.739 5.080 max 5.090 mean 10.010 10.579 max 10.582 mean 10.580 5.030 max 5.120 mean 5.075 9.330 max 9.770 mean 9.550 10.835 max*10.838 mean 10.836 5.000 max 5.010 mean 5.005 7.580 max 9.460 mean 8.520 10.739 max 10.741 mean 10.740
1367 1368 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1381 1382 1383 1384 1384 1385 1386 1387 1388 1388 1388 1388 1388 1388 1389 1390 1391 1392 1393	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient	H mi GPU 64 COO mi CSR mi H mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 12.041 max*2.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 2.920 max* 3.140 mean in 5.550 max 5.980 mean in 2.760 max 3.020 mean in 2.760 max 10.381 mean in 2.800 max 3.040 mean in 5.330 max* 6.020 mean in 5.330 max* 6.020 mean in 9.179 max 3.925 mean in 0.000 max 5.840 mean in 0.000 max 5.840 mean in 10.587 max*10.596 mean	1 4.403 1 11.113 1 3.804 1 4.308 1 12.043 1 3.819 1 4.259 1 11.876 1 3.048 1 5.803 1 8.600 1 2.898 1 5.632 1 10.379 2 9.944 5.742 9.922 1 2.926 1 5.513 1 10.591	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448 1 1450 1 1451 1 1452 1 1453 1 1454 1 1455 1 1456 1 1457 1 1458 1 1459 1 1460 1 1461 1 1462 1 1463 1 1464	mult_dcop_03.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute	CSR min H GPU 64 COO min CSR min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 10.739 5.080 max 10.739 mean 10.739 5.080 max 5.090 mean 5.085 9.720 max 10.380 mean 10.580 10.579 max 10.582 mean 10.580 5.030 max 5.120 mean 5.075 9.330 max 9.770 mean 9.550 10.835 max*10.838 mean 10.836 5.000 max 5.010 mean 5.005 7.580 max 9.460 mean 8.520 10.739 max 10.741 mean 10.740 5.140 max* 5.140 mean 5.140 10.340 max*5.140 mean 5.140
1367 1368 1370 1371 1372 1373 1374 1375 1376 1377 1378 1381 1382 1383 1384 1385 1386 1387 1388 1389 1390 1391 1391	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient Column-Gradient	H mi GPU 64 COO mi H mi CSR mi H mi GPU 64 COO mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 12.041 max*12.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 2.920 max* 3.140 mean in 5.550 max 5.980 mean in 2.760 max 3.020 mean in 2.760 max 3.020 mean in 10.377 max 10.381 mean in 5.330 max* 6.020 mean in 9.919 max 9.925 mean in 2.720 max 3.010 mean in 0.000 max 5.840 mean in 10.587 max*10.596 mean in 10.587 max*10.596 mean in 2.780 max 3.030 mean	1. 4.403 1. 11.113 1. 3.804 1. 4.308 1. 12.043 1. 3.819 1. 4.259 1. 1.876 1. 3.048 1. 5.803 1. 8.600 1. 2.898 1. 5.632 1. 10.379 1. 2.944 1. 5.742 1. 9.922 1. 9.923 1. 9.924 1. 9.925 1.	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1450 1 1451 1 1452 1 1453 1 1454 1 1455 1 1456 1 1457 1 1458 1 1459 1 1460 1 1461 1 1462 1 1463 1 1464 1	mult_dcop_03.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute mult_dcop_03.mtx Regular	CSR min H GPU 64 COO min CSR min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 9.425 10.739 max 10.739 mean 10.739 5.080 max 5.090 mean 10.010 10.579 max 10.582 mean 10.580 5.030 max 5.120 mean 5.075 9.330 max 9.770 mean 9.550 10.835 max*10.838 mean 10.836 5.000 max 5.010 mean 5.005 7.580 max 9.460 mean 8.520 10.739 max 10.741 mean 10.740
1367 1368 1370 1371 1372 1373 1374 1375 1376 1377 1378 1376 1381 1382 1383 1384 1385 1386 1387 1388 1389 1391 1392 1393	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient Column-Gradient	H mi GPU 64 COO mi GPU 64 COO mi CSR mi H mi GPU 64 COO mi CSR mi CSR mi GPU 64 COO mi CSR mi CSR mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 12.041 max*2.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 5.550 max 5.980 mean in 5.550 max 5.980 mean in 5.600 max 8.600 mean in 2.760 max 3.020 mean in 10.377 max 10.381 mean in 10.377 max 10.381 mean in 9.919 max 9.925 mean in 9.919 max 9.925 mean in 0.000 max 5.840 mean in 0.000 max 5.840 mean in 0.000 max 5.840 mean in 10.587 max*10.596 mean in 10.587 max*10.596 mean in 2.780 max 3.030 mean	1 4.403 1 11.113 1 3.804 1 4.308 1 12.043 1 3.819 1 4.259 1 11.876 1 3.048 1 5.803 1 8.600 1 2.898 1 5.632 1 10.379 1 2.944 1 5.742 1 9.922 1 2.944 1 5.5513 1 10.591	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448 1 1450 1 1451 1 1452 1 1453 1 1454 1 1455 1 1456 1 1451 1 1452 1 1453 1 1454 1 1455 1 1456 1 1466 1 1461 1 1462 1 1462 1 1466 1	mult_dcop_03.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute	CSR min H min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 10.739 5.080 max 5.090 mean 10.739 5.080 max 10.390 mean 10.010 10.579 max 10.582 mean 10.580 5.030 max 5.120 mean 5.075 9.330 max 9.770 mean 9.550 10.835 max*10.838 mean 10.836 5.000 max 5.010 mean 5.005 7.580 max 9.460 mean 8.520 10.739 max 10.741 mean 10.740 5.140 max* 5.140 mean 5.140 10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689
1367 1368 1370 1371 1372 1373 1374 1375 1377 1378 1377 1378 1379 1380 1381 1382 1383 1384 1385 1386 1387 1388 1389 1390 1391 1392 1393 1393 1393 1393 1393 1393	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient Column-Gradient	H mi GPU 64 COO mi GPU 64 COO mi CSR mi H mi GPU 64 COO mi CSR mi CSR mi GPU 64 COO mi CSR mi CSR mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 12.041 max*12.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 2.920 max* 3.140 mean in 5.550 max 5.980 mean in 2.760 max 3.020 mean in 2.760 max 3.020 mean in 10.377 max 10.381 mean in 5.330 max* 6.020 mean in 9.919 max 9.925 mean in 2.720 max 3.010 mean in 0.000 max 5.840 mean in 10.587 max*10.596 mean in 10.587 max*10.596 mean in 2.780 max 3.030 mean	1. 4.403 1. 11.113 1. 3.804 1. 4.308 1. 12.043 1. 3.819 1. 4.259 1. 11.876 1. 3.048 1. 5.803 1. 8.600 1. 2.898 1. 5.632 1. 10.379 1. 2.944 1. 5.742 1. 9.922 1. 2.926 1. 5.513 1. 10.591 1. 2.939 1. 5.667 1. 10.379	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1450 1 1451 1 1452 1 1453 1 1454 1 1455 1 1456 1 1457 1 1458 1 1459 1 1460 1 1461 1 1462 1 1463 1 1464 1 1465 1 1466 1 1467 1	mult_dcop_03.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute mult_dcop_03.mtx Regular	CSR min H min CSR min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 10.739 5.080 max 5.090 mean 10.739 5.080 max 10.739 mean 10.739 10.579 max 10.582 mean 10.580 5.030 max 5.120 mean 5.075 9.330 max 9.770 mean 9.550 10.835 max*10.838 mean 10.836 5.000 max 5.010 mean 5.005 7.580 max 9.460 mean 8.520 10.739 max 10.741 mean 10.740 5.140 max* 5.140 mean 5.40 5.140 max* 5.140 mean 5.40 5.140 max* 5.140 mean 9.689 9.689 max 9.689 mean 9.689
1367 1368 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1381 1382 1383 1384 1385 1386 1387 1398 1399 1390 1391 1392 1393	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute	H mi GPU 64 COO mi GPU 64 COO mi CSR mi H mi GPU 64 COO mi CSR mi CSR mi GPU 64 COO mi CSR mi CSR mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 12.041 max*2.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 5.550 max 5.980 mean in 5.550 max 5.980 mean in 5.600 max 8.600 mean in 2.760 max 3.020 mean in 10.377 max 10.381 mean in 10.377 max 10.381 mean in 9.919 max 9.925 mean in 9.919 max 9.925 mean in 0.000 max 5.840 mean in 0.000 max 5.840 mean in 0.000 max 5.840 mean in 10.587 max*10.596 mean in 10.587 max*10.596 mean in 2.780 max 3.030 mean	1. 4.403 1. 11.113 1. 3.804 1. 4.308 1. 12.043 1. 3.819 1. 4.259 1. 11.876 1. 3.048 1. 5.803 1. 8.600 1. 2.898 1. 5.632 1. 10.379 1. 2.944 1. 5.742 1. 9.922 1. 9.922 1. 9.922 1. 9.922 1. 9.922 1. 9.922 1. 9.922 1. 9.922 1. 9.939 1. 2.939 1. 5.667 1. 10.379	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448 1 1450 1 1451 1 1452 1 1453 1 1454 1 1457 1 1458 1 1450 1 1461 1 1462 1 1463 1 1464 1 1465 1 1466 1 1467 1 1468	mult_dcop_03.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute mult_dcop_03.mtx Regular	CSR min H GPU 64 COO min CSR min CSR min CSR min CSR min CSR min CSR min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 10.739 5.080 max 5.090 mean 10.010 10.579 max 10.582 mean 10.580 5.030 max 5.120 mean 5.075 9.330 max 9.770 mean 9.550 10.835 max*10.838 mean 10.836 5.000 max 5.010 mean 5.005 7.580 max 9.460 mean 8.520 10.739 max 10.741 mean 10.740 5.140 max* 5.140 mean 5.140 10.340 max*10.339 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 4.990 mean 4.980
1367 1368 1370 1371 1372 1373 1374 1375 1376 1377 1378 1381 1382 1383 1384 1386 1387 1388 1389 1390 1391 1392 1393 1394 1395 1395	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient Column-Gradient	H mi GPU 64 COO mi GSR mi H mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 12.041 max*2.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 5.550 max 5.980 mean in 5.550 max 5.980 mean in 5.600 max 3.020 mean in 10.377 max 10.381 mean in 10.377 max 10.381 mean in 9.919 max 9.925 mean in 0.000 max 5.840 mean in 10.587 max*10.596 mean in 10.587 max*10.596 mean in 2.780 max 3.030 mean in 2.780 max 3.032 mean in 2.780 max 3.032 mean	1. 4. 403 1. 11. 113 1. 3. 804 1. 4. 308 1. 12. 043 1. 3. 819 1. 4. 259 1. 11. 876 1. 3. 048 1. 5. 803 1. 8. 600 1. 2. 898 1. 5. 632 1. 10. 379 1. 2. 944 1. 5. 742 1. 9. 922 1. 10. 591 1. 10. 591 1. 2. 939 1. 5. 667 1. 10. 379	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448 1 1450 1 1451 1 1452 1 1453 1 1454 1 1455 1 1456 1 1457 1 1458 1 1450 1 1461 1 1462 1 1463 1 1464 1 1465 1 1466 1 1467 1 1468 1 1468 1 1468 1	mult_dcop_83.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute mult_dcop_83.mtx Regular Row-Premute	CSR min H GPU 64 COO min CSR min CSR min CSR min CSR min CSR min CSR min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 10.739 5.080 max 5.090 mean 10.739 5.080 max 10.739 mean 10.739 10.579 max 10.582 mean 10.580 5.030 max 5.120 mean 5.075 9.330 max 9.770 mean 9.550 10.835 max*10.838 mean 10.836 5.000 max 5.010 mean 5.005 7.580 max 9.460 mean 8.520 10.739 max 10.741 mean 10.740 5.140 max* 5.140 mean 5.40 5.140 max* 5.140 mean 5.40 5.140 max* 5.140 mean 9.689 9.689 max 9.689 mean 9.689
1367 1368 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381 1382 1383 1384 1385 1386 1387 1389 1391 1392 1393 1394 1395 1396 1397	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute	H mi GPU 64 COO mi GPU 64 COO mi CSR mi H mi GPU 64 COO mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 12.041 max*2.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 2.920 max* 3.140 mean in 5.550 max 5.930 mean in 8.600 max 8.600 mean in 2.760 max 10.381 mean in 10.377 max 10.381 mean in 2.800 max 3.040 mean in 9.919 max 9.925 mean in 9.919 max 9.925 mean in 10.587 max*10.596 mean in 10.587 max*10.596 mean in 10.587 max*10.596 mean in 2.780 max 3.030 mean in 4.860 max 5.840 mean in 10.587 max*10.596 mean in 2.780 max 3.030 mean in 4.860 max 5.840 mean in 4.860 max 5.840 mean in 10.587 max*10.596 mean in 10.587 max*10.596 mean	1. 4. 403 1. 11. 113 1. 3. 804 1. 4. 308 1. 12. 043 1. 3. 819 1. 4. 259 1. 11. 876 1. 3. 048 1. 5. 803 1. 8. 600 1. 2. 898 1. 5. 632 1. 10. 379 1. 2. 944 1. 5. 742 1. 9. 922 1. 9. 922 1. 10. 591 1. 10. 591 1. 10. 591 1. 10. 379 1. 10. 379 1. 10. 379	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448 1 1451 1 1451 1 1452 1 1453 1 1454 1 1455 1 1456 1 1457 1 1460 1 1461 1 1462 1 1463 1 1464 1 1465 1 1466 1 1467 1 1468 1 1469 1 1470	mult_dcop_03.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute mult_dcop_03.mtx Regular	CSR min H GPU 64 COO min CSR min GPU 64 COO min CSR min H GPU 64 COO min CSR min CSR min H GPU 64 COO min CSR min CSR min H GPU 64 COO min CSR min H GPU 64 COO min CSR min H GRU 65 COO min CSR min H	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 10.739 5.080 max 5.090 mean 10.739 5.080 max 10.390 mean 10.010 10.579 max 10.582 mean 10.580 5.030 max 5.120 mean 5.075 9.330 max 9.770 mean 9.550 10.835 max*10.838 mean 10.836 5.000 max 5.010 mean 5.005 7.580 max 9.460 mean 8.520 10.739 max 10.741 mean 10.740 5.140 max* 5.140 mean 5.140 10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 9.425 10.739 max 10.739 mean 10.739
1367 1368 1370 1371 1372 1373 1374 1375 1377 1378 1379 1381 1382 1383 1384 1385 1386 1387 1391 1392 1393 1394 1395 1396 1397 1398	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute	H mi GPU 64 COO mi GPU 64 COO mi CSR mi H mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 12.041 max*2.045 mean in 3.780 max 3.860 mean in 1.873 max 11.877 mean in 2.920 max* 3.140 mean in 5.550 max 5.980 mean in 2.760 max 3.020 mean in 2.760 max 3.020 mean in 2.760 max 5.830 mean in 2.770 max 10.381 mean in 2.720 max 3.020 mean in 5.330 max*6.020 mean in 5.330 max*6.020 mean in 10.2770 max 3.030 mean in 10.587 max*10.596 mean in 10.587 max*10.596 mean in 10.587 max*10.596 mean in 4.660 max 3.030 mean in 4.660 max 3.030 mean in 4.660 max 10.382 mean in 0.000 max 0.000 mean	1. 4. 403 1. 11. 113 1. 3. 804 1. 4. 308 1. 12. 043 1. 3. 819 1. 4. 259 1. 11. 876 1. 3. 048 1. 5. 803 1. 8. 600 1. 2. 898 1. 5. 632 1. 10. 379 1. 2. 944 1. 5. 742 1. 9. 922 1. 2. 926 1. 5. 5. 513 1. 10. 591 1. 2. 939 1. 5. 667 1. 10. 379	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448 1 1450 1 1451 1 1452 1 1453 1 1454 1 1455 1 1456 1 1457 1 1460 1 1461 1 1466 1 1467 1 1468 1 1467 1 1468 1 1469 1 1470 1 1471	mult_dcop_83.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute mult_dcop_83.mtx Regular Row-Premute	CSR min H CSR min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 10.739 5.080 max 10.739 mean 10.739 5.080 max 5.090 mean 10.689 9.720 max 10.380 mean 10.580 5.030 max 5.120 mean 5.075 9.330 max 9.770 mean 9.550 10.835 max*10.838 mean 10.836 5.000 max 5.010 mean 5.025 7.580 max 9.460 mean 8.520 10.739 max 10.741 mean 10.740 5.140 max* 5.140 mean 10.740 5.140 max* 5.140 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 9.425 10.739 max 10.739 mean 10.739 5.080 max 5.090 mean 5.085
1367 1368 1370 1371 1372 1373 1374 1375 1376 1377 1378 1379 1380 1381 1382 1383 1384 1385 1386 1387 1390 1391 1392 1393 1394 1395 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 mi GPU 64 COO mi GPU 64 COO mi CSR mi H mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 12.041 max*2.045 mean in 3.780 max 3.860 mean in 4.090 max 4.290 mean in 11.873 max 11.877 mean in 2.920 max* 3.140 mean in 5.550 max 5.930 mean in 8.600 max 8.600 mean in 2.760 max 10.381 mean in 10.377 max 10.381 mean in 2.800 max 3.040 mean in 9.919 max 9.925 mean in 9.919 max 9.925 mean in 10.587 max*10.596 mean in 10.587 max*10.596 mean in 10.587 max*10.596 mean in 2.780 max 3.030 mean in 4.860 max 5.840 mean in 10.587 max*10.596 mean in 2.780 max 3.030 mean in 4.860 max 5.840 mean in 4.860 max 5.840 mean in 10.587 max*10.596 mean in 10.587 max*10.596 mean	1. 4.403 1. 11.113 1. 3.804 1. 4.308 1. 2.043 1. 3.819 1. 4.259 1. 1.876 1. 3.048 1. 5.803 1. 8.600 1. 2.898 1. 5.632 1. 10.379 1. 2.944 1. 5.742 1. 9.922 1. 2.926 1. 5.513 1. 6.591 1. 6.791 1. 6	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1450 1 1451 1 1452 1 1453 1 1454 1 1457 1 1458 1 1450 1 1461 1 1462 1 1462 1 1463 1 1464 1 1463 1 1464 1 1465 1 1466 1 1467 1 1468 1 1469 1 1471 1 1472	mult_dcop_83.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute mult_dcop_83.mtx Regular Row-Premute	CSR min H min GPU 64 COO min GSR min H GSR min H GPU 64 COO min GSR min H min GPU 64 COO min GSR min H min GSR min H min GSR min	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 10.739 5.080 max 5.090 mean 10.010 10.579 max 10.582 mean 10.580 5.030 max 5.120 mean 5.075 9.330 max 9.770 mean 9.550 10.835 max*10.838 mean 10.836 5.000 max 5.010 mean 5.005 7.580 max 9.460 mean 8.520 10.739 max 10.741 mean 10.740 5.140 max* 5.140 mean 5.140 10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 9.425 10.739 max 10.739 mean 10.739 5.080 max 5.090 mean 10.739
1367 1368 1370 1371 1372 1373 1374 1375 1377 1378 1379 1381 1382 1383 1384 1385 1386 1387 1391 1392 1393 1394 1395 1396 1397 1398	Row-Column-Permute shermanACb.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute	H mi GPU 64 COO mi GPU 64 COO mi CSR mi H mi	in 11.109 max 11.116 mean in 3.690 max 3.870 mean in 4.260 max 4.340 mean in 12.041 max*12.045 mean in 12.041 max*2.045 mean in 3.780 max 3.860 mean in 1.873 max 11.877 mean in 2.920 max* 3.140 mean in 5.550 max 5.980 mean in 2.760 max 3.020 mean in 2.760 max 3.020 mean in 2.760 max 5.830 mean in 2.770 max 10.381 mean in 2.720 max 3.020 mean in 5.330 max*6.020 mean in 5.330 max*6.020 mean in 10.2770 max 3.030 mean in 10.587 max*10.596 mean in 10.587 max*10.596 mean in 10.587 max*10.596 mean in 4.660 max 3.030 mean in 4.660 max 3.030 mean in 4.660 max 10.382 mean in 0.000 max 0.000 mean	1. 4.403 1. 11.113 1. 3.804 1. 4.308 1. 2.043 1. 3.819 1. 4.259 1. 1.876 1. 3.048 1. 5.803 1. 8.600 1. 2.898 1. 5.632 1. 10.379 1. 2.944 1. 5.742 1. 9.922 1. 2.926 1. 5.513 1. 6.591 1. 6.791 1. 6	1440 1 1441 1 1442 1 1443 1 1444 1 1445 1 1446 1 1447 1 1448 1 1450 1 1451 1 1452 1 1453 1 1454 1 1455 1 1456 1 1457 1 1460 1 1461 1 1466 1 1467 1 1468 1 1467 1 1468 1 1469 1 1470 1 1471	mult_dcop_83.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute mult_dcop_83.mtx Regular Row-Premute	CSR min H min GPU 64 COO min GSR min H GSR min H GPU 64 COO min GSR min H min GPU 64 COO min GSR min H min GSR min H GSR min GSR m	10.340 max*10.390 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 10.739 5.080 max 10.739 mean 10.739 5.080 max 5.090 mean 10.689 9.720 max 10.380 mean 10.580 5.030 max 5.120 mean 5.005 9.330 max 9.770 mean 9.550 10.835 max*10.838 mean 10.836 5.000 max 5.010 mean 5.005 10.739 max 10.741 mean 10.740 5.140 max* 5.140 mean 10.740 5.140 max* 5.140 mean 10.740 5.140 max* 5.140 mean 10.365 9.689 max 9.689 mean 9.689 4.970 max 4.990 mean 4.980 9.420 max 9.430 mean 9.425 10.739 max 10.739 mean 10.739 5.080 max 5.090 mean 5.085

1474				
	Column-Gradient		1548	CSR min 6.360 max 7.450 mean 6.711
1475		GPU 64 COO min 5.030 max 5.120 mean 5.075	1549	H min 11.109 max 11.109 mean 11.109
1476		CSR min 9.330 max 9.770 mean 9.550	1550 Row-Premute	
1477		H min 10.835 max*10.838 mean 10.836	1551	GPU 64 COO min 3.950 max* 3.980 mean 3.953
1478	Row-Column-Permute		1552	CSR min 6.330 max 7.400 mean 6.661
1479		GPU 64 COO min 5.000 max 5.010 mean 5.005	1553	H min 11.098 max 11.104 mean 11.101
1480		CSR min 7.580 max 9.460 mean 8.520	1554 Row-Gradient	
1481		H min 10.739 max 10.741 mean 10.740	1555	GPU 64 COO min 3.960 max 3.980 mean 3.961
1482	mult_dcop_03.mtx		1556	CSR min 6.270 max*10.770 mean 7.017
1483	Regular		1557	H min 11.109 max 11.109 mean 11.109
1484		GPU 64 COO min 5.130 max* 5.220 mean 5.142	1558 Column-Gradient	
1485		CSR min 7.250 max* 9.320 mean 7.722	1559	GPU 64 COO min 3.940 max 3.960 mean 3.950
1486		H min 9.689 max 9.689 mean 9.689	1560	CSR min 6.270 max 7.370 mean 6.696
1487	Row-Premute		1561	H min 11.329 max*11.334 mean 11.331
1488		GPU 64 COO min 4.980 max 5.030 mean 4.999	1562 Row-Column-Permute	
1489		CSR min 6.460 max 8.470 mean 6.950	1563	GPU 64 COO min 3.950 max 3.960 mean 3.952
1490		H min 10.738 max 10.742 mean 10.740	1564	CSR min 6.180 max 7.420 mean 6.641
1491	Row-Gradient	11 IIII 10.750 IIIAX 10.742 IIICAII 10.740	1565	H min 11.098 max 11.105 mean 11.101
1492	Now-Gradient	GPU 64 COO min 5.070 max 5.140 mean 5.088		II IIII II.030 IIIAX II.103 IIIEAII II.101
1493		CSR min 6.780 max 8.700 mean 7.268	1567 Regular	
1494		H min 10.572 max 10.584 mean 10.580	1568	GPU 64 COO min 0.000 max 0.000 mean 0.000
1495	Column-Gradient		1569	CSR min 0.000 max 0.000 mean 0.000
1496		GPU 64 COO min 4.980 max 5.030 mean 5.010	1570	H min 7.205 max 7.205 mean 7.205
1497		CSR min 6.390 max 7.640 mean 6.982	1571 Row-Premute	
1498		H min 10.825 max*10.845 mean 10.836	1572	GPU 64 COO min 4.020 max 4.030 mean 4.023
1499	Row-Column-Permute		1573	CSR min 6.070 max 6.750 mean 6.340
1500		GPU 64 COO min 4.990 max 5.010 mean 4.997	1574	H min 11.025 max 11.031 mean 11.028
1501		CSR min 6.300 max 7.160 mean 6.636	1575 Row-Gradient	
1502		H min 10.738 max 10.743 mean 10.740	1576	GPU 64 COO min 4.090 max* 4.160 mean 4.111
1503	mult_dcop_01.mtx		1577	CSR min 5.980 max* 7.370 mean 6.678
1504	Regular		1578	H min 10.295 max 10.304 mean 10.300
1505	кевита	GPU 64 COO min 5.120 max* 5.140 mean 5.134	1579 Column-Gradient	11 III11 10.255 IIIAX 10.304 IIIEAII 10.300
		CSR min 6.990 max* 9.230 mean 7.546		GPU 64 COO min 3.980 max 4.010 mean 3.995
1506			1580	
1507		H min 9.689 max 9.689 mean 9.689	1581	CSR min 5.880 max 6.780 mean 6.295
1508	Row-Premute		1582	H min 10.881 max*10.887 mean 10.883
1509		GPU 64 COO min 4.990 max 5.020 mean 5.004	1583 Row-Column-Permute	
1510		CSR min 6.370 max 7.220 mean 6.771	1584	GPU 64 COO min 4.020 max 4.030 mean 4.023
1511		H min 10.738 max 10.743 mean 10.740	1585	CSR min 5.970 max 6.420 mean 6.183
1512	Row-Gradient		1586	H min 11.025 max 11.033 mean 11.028
1513		GPU 64 COO min 5.060 max 5.100 mean 5.082	1587 lp_osa_07.mtx	
1514		CSR min 6.730 max 7.720 mean 7.317	1588 Regular	
				GPU 64 COO min 4.260 max* 4.270 mean 4.261
		H min 10.574 max 10.585 mean 10.580	1589	
1515 1516	Column-Gradient	H min 10.574 max 10.585 mean 10.580		
1516	Column-Gradient		1590	CSR min 6.440 max 7.640 mean 6.863
1516 1517	Column-Gradient	GPU 64 COO min 4.980 max 5.100 mean 5.012	1590 1591	
1516 1517 1518	Column-Gradient	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054	1590 1591 1592 Row-Premute	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412
1516 1517 1518 1519		GPU 64 COO min 4.980 max 5.100 mean 5.012	1590 1591 1592 Row-Premute 1593	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 4.200 mean 4.200
1516 1517 1518 1519 1520	Column-Gradient Row-Column-Permute	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835	1590 1591 1592 Row-Premute 1593 1594	CFR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 4.200 mean 4.200 CSR min 6.020 max 7.030 mean 6.418
1516 1517 1518 1519 1520 1521		GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986	1590 1591 1592 Row-Premute 1593 1594	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 4.200 mean 4.200
1516 1517 1518 1519 1520 1521 1522		GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 4.200 mean 4.200
1516 1517 1518 1519 1520 1521 1522 1523	Row-Column-Permute	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 4.200 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 4.226
1516 1517 1518 1519 1520 1521 1522 1523 1524	Row-Column-Permute mult_dcop_02.mtx	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597	CFR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 7.030 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 4.226 CSR min 6.070 max*10.050 mean 6.498
1516 1517 1518 1519 1520 1521 1522 1523 1524 1525	Row-Column-Permute	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 4.200 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 4.226
1516 1517 1518 1519 1520 1521 1522 1523 1524	Row-Column-Permute mult_dcop_02.mtx	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597	CFR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 7.030 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 4.226 CSR min 6.070 max*10.050 mean 6.498
1516 1517 1518 1519 1520 1521 1522 1523 1524 1525	Row-Column-Permute mult_dcop_02.mtx	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598	CFR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 7.030 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 4.226 CSR min 6.070 max*10.050 mean 6.498
1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526	Row-Column-Permute mult_dcop_02.mtx	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598 1599 1600 Column-Gradient	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 7.030 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 4.226
1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526 1527	Row-Column-Permute mult_dcop_02.mtx	GPU 64 COO min	1590 1591 1592 Row-Premute 1593 1594 1596 Row-Gradient 1597 1598 1599 Column-Gradient 1601	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 4.200 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 4.226 CSR min 6.070 max 4.240 mean 6.498 H min 8.607 max 8.678 mean 8.671
1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526 1527 1528 1529	Row-Column-Permute mult_dcop_02.mtx Regular	GPU 64 COO min 4.980 max 7.510 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.120 max 5.140 mean 5.133 CSR min 6.950 max 7.590 mean 7.336 H min 9.689 max 9.689 mean 9.689	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598 1599 1600 Column-Gradient 1601 1602	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 7.030 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 4.226 CSR min 6.070 max*10.050 mean 6.498 H min 8.607 max 8.678 mean 8.671 GPU 64 COO min 4.170 max 4.190 mean 4.180 CSR min 5.610 max 7.300 mean 5.988
1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526 1527 1528 1529 1530	Row-Column-Permute mult_dcop_02.mtx Regular	CPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 CPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740 CPU 64 COO min 5.120 max 5.140 mean 5.133 CSR min 6.950 max 7.590 mean 7.336 H min 9.689 max 9.689 mean 9.689 CPU 64 COO min 4.970 max 4.990 mean 4.984	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598 1599 1600 Column-Gradient 1601 1602 1603	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 4.200 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 4.226 CSR min 6.070 max*10.050 mean 6.498 H min 8.607 max 8.678 mean 8.671 GPU 64 COO min 4.170 max 4.190 mean 4.180 CSR min 5.610 max 7.300 mean 5.988 H min 9.534 max* 9.601 mean 9.585
1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526 1527 1528 1529 1530	Row-Column-Permute mult_dcop_02.mtx Regular	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.120 max 5.140 mean 5.133 CSR min 6.950 max 7.590 mean 7.336 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.984 CSR min 6.440 max 7.110 mean 6.719	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598 1599 1600 Column-Gradient 1601 1602 1603 1604 Row-Column-Permute	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 7.030 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 4.226 CSR min 6.070 max 4.240 mean 6.498 H min 8.607 max 8.678 mean 8.671 GPU 64 COO min 4.170 max 4.190 mean 5.988 H min 9.534 max* 9.601 mean 9.585
1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526 1527 1528 1529 1530 1531	Row-Column-Permute mult_dcop_02.mtx Regular Row-Premute	CPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 CPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740 CPU 64 COO min 5.120 max 5.140 mean 5.133 CSR min 6.950 max 7.590 mean 7.336 H min 9.689 max 9.689 mean 9.689 CPU 64 COO min 4.970 max 4.990 mean 4.984	1590 1591 1592 Row-Premute 1593 1594 1596 Row-Gradient 1597 1598 1599 1600 Column-Gradient 1601 1602 1603 1604 Row-Column-Permute	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 7.030 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 4.226 CSR min 6.070 max*10.050 mean 6.498 H min 8.607 max 8.678 mean 8.671 GPU 64 COO min 4.170 max 7.300 mean 5.988 H min 9.534 max* 9.601 mean 9.585 GPU 64 COO min 4.190 max 7.300 mean 6.858 GPU 64 COO min 4.190 max 4.190 mean 4.190 CSR min 6.070 max 4.190 mean 4.190 CSR min 6.070 max 7.000 mean 6.386
1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526 1527 1528 1529 1530 1531 1532	Row-Column-Permute mult_dcop_02.mtx Regular	GPU 64 COO min 4.980 max 7.510 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.120 max 5.140 mean 5.133 CSR min 6.950 max 7.590 mean 7.336 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.984 CSR min 6.440 max 7.110 mean 6.719 H min 10.738 max 10.742 mean 10.740	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598 1599 1600 Column-Gradient 1601 1602 1603 1604 Row-Column-Permute 1605 1606	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 7.030 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 4.226 CSR min 6.070 max 4.240 mean 6.498 H min 8.607 max 8.678 mean 8.671 GPU 64 COO min 4.170 max 4.190 mean 5.988 H min 9.534 max* 9.601 mean 9.585
1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526 1527 1528 1529 1530 1531 1532 1533	Row-Column-Permute mult_dcop_02.mtx Regular Row-Premute	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.120 max 5.140 mean 5.133 CSR min 6.950 max 7.590 mean 7.336 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.984 CSR min 6.440 max 7.110 mean 6.719 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.070 max* 5.150 mean 5.086	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598 1599 1600 Column-Gradient 1601 1602 1603 1604 Row-Column-Permute 1605 1606 1607 1608 ex19.mtx	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 7.030 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 4.226 CSR min 6.070 max*10.050 mean 6.498 H min 8.607 max 8.678 mean 8.671 GPU 64 COO min 4.170 max 7.300 mean 5.988 H min 9.534 max* 9.601 mean 9.585 GPU 64 COO min 4.190 max 7.300 mean 6.858 GPU 64 COO min 4.190 max 4.190 mean 4.190 CSR min 6.070 max 4.190 mean 4.190 CSR min 6.070 max 7.000 mean 6.386
1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526 1527 1528 1529 1530 1531 1532 1533 1534 1535	Row-Column-Permute mult_dcop_02.mtx Regular Row-Premute	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.120 max 5.140 mean 5.133 CSR min 6.950 max 7.590 mean 7.336 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.984 CSR min 6.440 max 7.110 mean 6.719 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.070 max* 5.150 mean 5.086 CSR min 6.650 max* 7.930 mean 7.304	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598 1599 1600 Column-Gradient 1601 1602 1603 1604 Row-Column-Permute 1605 1606 1607 1608 ex19.mtx 1609 Row-Row-Premute	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 7.030 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 6.498 H min 8.607 max 8.678 mean 8.671 GPU 64 COO min 4.170 max 4.190 mean 5.988 H min 9.534 max* 9.601 mean 9.585 GPU 64 COO min 4.170 max 7.300 mean 5.988 H min 9.534 max* 9.601 mean 9.585 GPU 64 COO min 4.190 max 7.300 mean 6.386 H min 9.555 max 9.257 mean 9.256
1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526 1527 1528 1529 1530 1531 1532 1533 1534 1535	Row-Column-Permute mult_dcop_02.mtx Regular Row-Premute Row-Gradient	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.120 max 5.140 mean 5.133 CSR min 6.950 max 7.590 mean 7.336 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.984 CSR min 6.440 max 7.110 mean 6.719 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.070 max* 5.150 mean 5.086	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598 1599 1600 Column-Gradient 1601 1602 1603 1604 Row-Column-Permute 1606 1607 1608 ex19.mtx 1609 1610	CPU 64 COO min 4.170 max 4.190 mean 4.180 CPU 64 COO min 4.270 max 8.671 GPU 64 COO min 4.210 max 4.240 mean 4.226 CPU 64 COO min 4.210 max 4.240 mean 4.226 CPU 64 COO min 6.070 max*10.050 mean 6.498 H min 8.607 max 8.678 mean 8.671 GPU 64 COO min 4.170 max 4.190 mean 4.180 CPU 64 COO min 4.170 max 7.300 mean 5.988 H min 9.534 max* 9.601 mean 9.585 GPU 64 COO min 4.190 max 4.190 mean 4.190 CPU 64 COO min 6.070 max 7.000 mean 6.386 H min 9.255 max 9.257 mean 9.256
1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526 1527 1528 1529 1530 1531 1532 1533 1534 1535 1535	Row-Column-Permute mult_dcop_02.mtx Regular Row-Premute	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.120 max 5.140 mean 5.133 CSR min 6.950 max 7.590 mean 7.336 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.984 CSR min 6.440 max 7.110 mean 6.719 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.070 max* 5.150 mean 7.304 H min 10.738 max 10.742 mean 10.740	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598 1599 1600 Column-Gradient 1601 1602 1603 1604 Row-Column-Permute 1605 1606 1607 1608 ex19.mtx 1609 Regular 1611	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 4.200 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 6.498 H min 8.607 max 10.850 mean 6.498 H min 8.607 max 8.678 mean 8.671 GPU 64 COO min 4.170 max 4.190 mean 4.180 CSR min 5.610 max 7.300 mean 5.988 H min 9.534 max* 9.601 mean 9.585 GPU 64 COO min 4.190 max 4.190 mean 4.190 CSR min 6.070 max 7.000 mean 6.386 H min 9.255 max 9.257 mean 9.256
1516 1517 1518 1520 1521 1522 1523 1524 1525 1526 1527 1528 1529 1530 1531 1532 1533 1534 1535 1536	Row-Column-Permute mult_dcop_02.mtx Regular Row-Premute Row-Gradient	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.120 max 5.140 mean 5.133 CSR min 6.950 max 7.590 mean 7.336 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.984 CSR min 6.440 max 7.110 mean 6.719 H min 10.738 max 10.742 mean 10.740 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 5.086	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598 1599 1600 Column-Gradient 1601 1602 1603 1604 Row-Column-Permute 1605 1606 1607 1608 ex19.mtx 1609 Regular 1611	CPU 64 COO min 4.170 max 4.190 mean 4.180 CPU 64 COO min 4.270 max 8.671 GPU 64 COO min 4.210 max 4.240 mean 4.226 CPU 64 COO min 4.210 max 4.240 mean 4.226 CPU 64 COO min 6.070 max*10.050 mean 6.498 H min 8.607 max 8.678 mean 8.671 GPU 64 COO min 4.170 max 4.190 mean 4.180 CPU 64 COO min 4.170 max 7.300 mean 5.988 H min 9.534 max* 9.601 mean 9.585 GPU 64 COO min 4.190 max 4.190 mean 4.190 CPU 64 COO min 6.070 max 7.000 mean 6.386 H min 9.255 max 9.257 mean 9.256
1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526 1527 1528 1529 1530 1531 1532 1533 1534 1535 1535	Row-Column-Permute mult_dcop_02.mtx Regular Row-Premute Row-Gradient	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.120 max 5.140 mean 5.133 CSR min 6.950 max 7.590 mean 7.336 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.984 CSR min 6.440 max 7.110 mean 6.719 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.070 max* 5.150 mean 7.304 H min 10.738 max 10.742 mean 10.740	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598 1599 1600 Column-Gradient 1601 1602 1603 1604 Row-Column-Permute 1605 1606 1607 1608 ex19.mtx 1609 Regular 1611	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 4.200 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 6.498 H min 8.607 max 10.850 mean 6.498 H min 8.607 max 8.678 mean 8.671 GPU 64 COO min 4.170 max 4.190 mean 4.180 CSR min 5.610 max 7.300 mean 5.988 H min 9.534 max* 9.601 mean 9.585 GPU 64 COO min 4.190 max 4.190 mean 4.190 CSR min 6.070 max 7.000 mean 6.386 H min 9.255 max 9.257 mean 9.256
1516 1517 1518 1520 1521 1522 1523 1524 1525 1526 1527 1528 1529 1530 1531 1532 1533 1534 1535 1536	Row-Column-Permute mult_dcop_02.mtx Regular Row-Premute Row-Gradient	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.120 max 5.140 mean 5.133 CSR min 6.950 max 7.590 mean 7.336 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.984 CSR min 6.440 max 7.110 mean 6.719 H min 10.738 max 10.742 mean 10.740 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 5.086	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598 1599 1600 Column-Gradient 1601 1602 1603 1604 Row-Column-Permute 1605 1606 1607 1608 ex19.mtx 1609 Regular 1611	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 4.200 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 6.498 H min 8.607 max 10.850 mean 6.498 H min 8.607 max 8.678 mean 8.671 GPU 64 COO min 4.170 max 4.190 mean 4.180 CSR min 5.610 max 7.300 mean 5.988 H min 9.534 max* 9.601 mean 9.585 GPU 64 COO min 4.190 max 4.190 mean 4.190 CSR min 6.070 max 7.000 mean 6.386 H min 9.255 max 9.257 mean 9.256
1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526 1527 1528 1529 1530 1531 1533 1533 1533 1533 1533 1533	Row-Column-Permute mult_dcop_02.mtx Regular Row-Premute Row-Gradient	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.120 max 5.140 mean 5.133 CSR min 6.950 max 7.590 mean 7.336 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.984 CSR min 6.440 max 7.110 mean 6.719 H min 10.738 max 10.742 mean 10.740 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	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598 1599 1600 Column-Gradient 1601 1602 1603 1604 Row-Column-Permute 1605 1606 1607 1608 ex19.mtx 1609 Regular 1610 1611 1612 1613 Row-Premute	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 7.030 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 6.498 H min 8.607 max 4.190 mean 6.498 H min 9.534 max* 9.601 mean 9.585 GPU 64 COO min 4.170 max 4.190 mean 6.71 GPU 64 COO min 6.100 max 4.190 mean 6.988 H min 9.534 max* 9.601 mean 9.585 GPU 64 COO min 6.100 max 4.190 mean 6.386 H min 9.255 max 9.257 mean 9.256
1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526 1527 1531 1531 1531 1533 1535 1536 1537 1538 1539 1539	Row-Column-Permute mult_dcop_02.mtx Regular Row-Premute Row-Gradient Column-Gradient	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.120 max 5.140 mean 5.133 CSR min 6.950 max 7.590 mean 7.336 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.984 CSR min 6.440 max 7.110 mean 6.719 H min 10.738 max 10.742 mean 10.740 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	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598 1599 1600 Column-Gradient 1601 1602 1603 1604 Row-Column-Permute 1605 1606 1607 1608 ex19.mtx 1609 Regular 1610 1611 1611 1612 1613 Row-Premute	CPU 64 COO min 4.170 max 4.190 mean 4.180 CPU 64 COO min 4.170 max 4.290 mean 4.226 CSR min 6.020 max 4.240 mean 4.226 CSR min 6.020 max 7.030 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 4.226 CSR min 6.070 max*10.050 mean 6.498 H min 8.607 max 8.678 mean 8.671 GPU 64 COO min 4.170 max 4.190 mean 4.180 CSR min 5.610 max 7.300 mean 5.988 H min 9.534 max* 9.601 mean 9.585 GPU 64 COO min 4.190 max 4.190 mean 4.190 CSR min 6.070 max 7.000 mean 6.386 H min 9.255 max 9.257 mean 9.256 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
1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526 1527 1528 1530 1531 1533 1534 1533 1534 1535 1536 1537 1538 1538 1538	Row-Column-Permute mult_dcop_02.mtx Regular Row-Premute Row-Gradient Column-Gradient	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.120 max 5.140 mean 5.133 CSR min 6.950 max 7.590 mean 7.336 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.984 CSR min 6.440 max 7.110 mean 6.719 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.070 max* 5.150 mean 7.304 H min 10.738 max 10.587 mean 10.580 GPU 64 COO min 4.980 max 5.040 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	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598 1599 1600 Column-Gradient 1601 1602 1603 1604 Row-Column-Permute 1605 1606 1607 1608 ex19.mtx 1609 Regular 1610 1611 1612 1613 Row-Premute	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 4.200 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 6.498 H min 8.607 max 8.678 mean 8.671 GPU 64 COO min 4.170 max 4.190 mean 4.180 CSR min 5.610 max 7.300 mean 5.988 H min 9.534 max* 9.601 mean 9.585 GPU 64 COO min 4.190 max 4.190 mean 4.190 CSR min 6.070 max 7.000 mean 6.386 H min 9.535 max 9.257 mean 9.256 GPU 64 COO min 6.140 max 7.000 mean 6.386 H min 9.255 max 9.257 mean 9.256 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 8.228 mean 8.228 GPU 64 COO min 5.820 max 8.228 mean 8.228
1516 1517 1518 1519 1520 1521 1522 1523 1524 1525 1526 1527 1528 1520 1531 1530 1531 1533 1533 1533 1533 153	Row-Column-Permute mult_dcop_02.mtx Regular Row-Premute Row-Gradient Column-Gradient	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.120 max 5.140 mean 5.133 CSR min 6.950 max 7.590 mean 7.336 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.984 CSR min 6.440 max 7.110 mean 6.719 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.070 max* 5.150 mean 7.304 H min 10.574 max 10.587 mean 10.580 GPU 64 COO min 4.980 max 5.040 mean 5.085 CSR min 6.650 max* 7.650 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	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598 1599 1600 Column-Gradient 1601 1602 1603 1604 Row-Column-Permute 1605 1606 1607 1608 ex19.mtx 1609 Regular 1610 1611 1612 1613 Row-Premute 1614 1615 1616 1617 Row-Gradient	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 4.200 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 4.226 CSR min 6.070 max*10.050 mean 6.498 H min 8.607 max 8.678 mean 8.671 GPU 64 COO min 4.170 max 4.190 mean 4.180 CSR min 5.610 max 7.300 mean 5.988 H min 9.534 max* 9.601 mean 9.585 GPU 64 COO min 6.140 max 4.190 mean 6.386 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 6.140 max 6.180 mean 6.386 H min 9.255 max 9.257 mean 9.256 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 11.870 mean 10.372 H min 11.836 max 11.840 mean 11.838
1516 1517 1518 1520 1521 1522 1523 1524 1525 1526 1527 1528 1529 1530 1531 1531 1532 1533 1534 1535 1536 1537 1538 1536 1537 1538 1536 1537 1538 1536 1537 1538 1536 1537 1538 1538 1538 1538	Row-Column-Permute mult_dcop_02.mtx Regular Row-Premute Row-Gradient Column-Gradient	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.120 max 5.140 mean 5.133 CSR min 6.950 max 7.590 mean 7.336 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.984 CSR min 6.440 max 7.110 mean 6.719 H min 10.738 max 10.742 mean 10.740 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 5.040 mean 5.012 CSR min 6.520 max 7.650 mean 7.139 H min 10.829 max*10.846 mean 10.836	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598 1599 1600 Column-Gradient 1601 1602 1603 1604 Row-Column-Permute 1605 1606 1607 1608 ex19.mtx 1609 Regular 1611 1612 1613 Row-Premute 1614 1615 1616 1617 Row-Gradient	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 4.200 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 4.226 CSR min 6.070 max*10.850 mean 6.498 H min 8.607 max 8.678 mean 8.671 GPU 64 COO min 4.170 max 4.190 mean 4.180 CSR min 5.610 max 7.300 mean 5.988 H min 9.534 max* 9.601 mean 9.585 GPU 64 COO min 6.070 max 1.900 mean 6.386 H min 9.255 max 9.257 mean 9.256
1516 1517 1518 1519 1520 1522 1523 1524 1524 1526 1527 1528 1526 1527 1528 1530 1531 1533 1534 1533 1533 1533 1533 1533	Row-Column-Permute mult_dcop_02.mtx Regular Row-Premute Row-Gradient Column-Gradient Row-Column-Permute	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.120 max 5.140 mean 5.133 CSR min 6.950 max 7.590 mean 7.336 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.984 CSR min 6.440 max 7.110 mean 6.719 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.070 max* 5.150 mean 7.304 H min 10.574 max 10.587 mean 10.580 GPU 64 COO min 4.980 max 5.040 mean 5.085 CSR min 6.650 max* 7.650 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	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598 1599 1600 Column-Gradient 1601 1602 1603 1604 Row-Column-Permute 1605 1606 1607 1608 ex19.mtx 1609 Regular 1610 1611 1612 1613 Row-Premute 1614 1615 1616 1617 Row-Gradient 1618	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 4.200 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 6.498 H min 8.607 max 4.190 mean 6.498 H min 8.607 max 4.190 mean 4.180 CSR min 5.610 max 7.300 mean 5.988 H min 9.534 max* 9.601 mean 9.585 GPU 64 COO min 4.170 max 4.190 mean 4.180 CSR min 5.610 max 7.300 mean 5.988 H min 9.534 max* 9.601 mean 9.585 GPU 64 COO min 6.140 max 7.000 mean 6.386 H min 9.255 max 9.257 mean 9.256 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 11.840 mean 11.838 GPU 64 COO min 6.070 max 1.840 mean 13.322 H min 11.836 max 11.840 mean 11.838
1516 1517 1518 1520 1521 1522 1523 1524 1525 1526 1527 1528 1529 1530 1531 1531 1532 1533 1534 1535 1536 1537 1538 1536 1537 1538 1536 1537 1538 1536 1537 1538 1536 1537 1538 1538 1538 1538	Row-Column-Permute mult_dcop_02.mtx Regular Row-Premute Row-Gradient Column-Gradient	GPU 64 COO min 4.980 max 5.100 mean 5.012 CSR min 6.580 max 7.510 mean 7.054 H min 10.828 max*10.842 mean 10.835 GPU 64 COO min 4.970 max 5.000 mean 4.986 CSR min 6.390 max 7.050 mean 6.677 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.120 max 5.140 mean 5.133 CSR min 6.950 max 7.590 mean 7.336 H min 9.689 max 9.689 mean 9.689 GPU 64 COO min 4.970 max 4.990 mean 4.984 CSR min 6.440 max 7.110 mean 6.719 H min 10.738 max 10.742 mean 10.740 GPU 64 COO min 5.070 max* 5.150 mean 7.304 H min 10.574 max 10.587 mean 10.580 GPU 64 COO min 4.980 max 5.040 mean 5.085 CSR min 6.650 max* 7.650 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	1590 1591 1592 Row-Premute 1593 1594 1595 1596 Row-Gradient 1597 1598 1599 1600 Column-Gradient 1601 1602 1603 1604 Row-Column-Permute 1605 1606 1607 1608 ex19.mtx 1609 Regular 1611 1612 1613 Row-Premute 1614 1615 1616 1617 Row-Gradient	CSR min 6.440 max 7.640 mean 6.863 H min 8.412 max 8.412 mean 8.412 GPU 64 COO min 4.200 max 4.200 mean 6.418 H min 9.255 max 9.257 mean 9.256 GPU 64 COO min 4.210 max 4.240 mean 4.226 CSR min 6.070 max*10.850 mean 6.498 H min 8.607 max 8.678 mean 8.671 GPU 64 COO min 4.170 max 4.190 mean 4.180 CSR min 5.610 max 7.300 mean 5.988 H min 9.534 max* 9.601 mean 9.585 GPU 64 COO min 6.070 max 1.900 mean 6.386 H min 9.255 max 9.257 mean 9.256

1622		GPU 64 COO min 5.760 max 5.840 mean 5.813	1696	H min 7.380 max 7.380 mean 7.380
1623		CSR min 9.710 max 14.220 mean 10.376	1697 Row-Premute	
1624		H min 11.873 max*11.882 mean 11.878	1698	GPU 64 COO min 4.130 max 4.170 mean 4.134
1625	Row-Column-Permute		1699	CSR min 6.180 max* 9.200 mean 6.796
1626		GPU 64 COO min 5.810 max 5.860 mean 5.838	1700	H min 10.041 max 10.046 mean 10.044
1627		CSR min 9.920 max 10.820 mean 10.240	1701 Row-Gradient	
1628		H min 11.836 max 11.841 mean 11.838	1702	GPU 64 COO min 4.150 max* 4.220 mean 4.163
1629	brainpc2.mtx		1703	CSR min 6.410 max 7.500 mean 6.816
1630	Regular		1704	H min 9.682 max 9.706 mean 9.693
1631		GPU 64 COO min 0.000 max 0.000 mean 0.000	1705 Column-Gradient	
1632		CSR min 0.000 max 0.000 mean 0.000	1706	GPU 64 COO min 4.080 max 4.110 mean 4.096
1633		H min 7.478 max 7.478 mean 7.478	1707	CSR min 6.020 max 7.220 mean 6.309
1634	Row-Premute		1708	H min 10.597 max*10.658 mean 10.631
1635		GPU 64 COO min 4.760 max 4.790 mean 4.773	1709 Row-Column-Permute	
1636		CSR min 6.930 max 7.780 mean 7.310	1710	GPU 64 COO min 4.120 max 4.140 mean 4.130
1637		H min 9.810 max 9.813 mean 9.811	1711	CSR min 6.210 max 7.200 mean 6.609
1638	Row-Gradient		1712	H min 10.041 max 10.046 mean 10.044
1639		GPU 64 COO min 4.820 max* 4.840 mean 4.831	1713 TSOPF_FS_b9_c6.mtx	
1640		CSR min 7.220 max 8.290 mean 7.583	1714 Regular	
1641		H min 9.721 max 9.725 mean 9.723	1715	GPU 64 COO min 0.000 max 0.000 mean 0.000
1642	Column-Gradient		1716	CSR min 0.000 max 0.000 mean 0.000
1643		GPU 64 COO min 4.760 max 4.820 mean 4.779	1717	H min 7.380 max 7.380 mean 7.380
1644		CSR min 6.870 max* 8.300 mean 7.393	1718 Row-Premute	
1645		H min 10.368 max*10.373 mean 10.370	1719	GPU 64 COO min 4.120 max 4.140 mean 4.129
1646	Row-Column-Permute		1720	CSR min 6.170 max 7.160 mean 6.664
1647		GPU 64 COO min 4.750 max 4.780 mean 4.765	1721	H min 10.041 max 10.045 mean 10.043
1648		CSR min 6.940 max 7.580 mean 7.298	1722 Row-Gradient	
1649		H min 9.809 max 9.814 mean 9.811	1723	GPU 64 COO min 4.150 max* 4.180 mean 4.162
1650	shermanACb.mtx		1724	CSR min 6.420 max 7.360 mean 6.723
1651	Regular		1725	H min 9.682 max 9.706 mean 9.693
1652		GPU 64 COO min 4.090 max* 4.130 mean 4.112	1726 Column-Gradient	
1653		CSR min 6.320 max* 7.200 mean 6.779	1727	GPU 64 COO min 4.080 max 4.120 mean 4.096
1654		H min 8.600 max 8.600 mean 8.600	1728	CSR min 5.880 max 7.090 mean 6.403
1655	Row-Premute		1729	H min 10.611 max*10.660 mean 10.637
1656		GPU 64 COO min 4.020 max 4.050 mean 4.036	1730 Row-Column-Permute	
1657		CSR min 5.670 max 6.460 mean 6.014	1731	GPU 64 COO min 4.130 max 4.140 mean 4.130
1658		H min 10.376 max 10.382 mean 10.379	1732	CSR min 6.330 max* 7.390 mean 6.695
1659	Row-Gradient		1733	H min 10.042 max 10.047 mean 10.044
1660		GPU 64 COO min 4.050 max 4.100 mean 4.074	1734 OPF_6000.mtx	
1661		CSR min 5.580 max 6.420 mean 5.996	1735 Regular	CDU 64 000 min - 7 070 mm - 7 070 mm - 7 000
1662		H min 9.918 max 9.924 mean 9.921	1736	GPU 64 COO min 7.270 max* 7.370 mean 7.293
1663	Column-Gradient		1737	CSR min 12.890 max*14.500 mean 13.566
1664		GPU 64 COO min 4.010 max 4.080 mean 4.033	1738	H min 8.799 max 8.799 mean 8.799
1665		CSR min 0.000 max 6.320 mean 5.527	1739 Row-Premute	CDU 54 000 m/m 5 540 mm 5 700 mm 5 670
1666 1667	Row-Column-Permute	H min 10.543 max*10.595 mean 10.589	1740 1741	GPU 64 COO min 6.640 max 6.720 mean 6.678 CSR min 9.680 max 11.600 mean 10.040
1668	Kow-Column-Permute	GPU 64 COO min 4.020 max 4.050 mean 4.036	1741	H min 11.873 max 11.877 mean 11.875
1669		CSR min 5.670 max 6.510 mean 6.092	1743 Row-Gradient	n min 11.0/3 max 11.0// mean 11.0/5
1670		H min 10.377 max 10.381 mean 10.379	1744 Kow-Gradient	GPU 64 COO min 7.090 max 7.140 mean 7.122
1671	cvxqp3.mtx	11 IIII 10.577 IIIAX 10.501 IIICAN 10.575	1745	CSR min 11.250 max 13.030 mean 12.142
1672	Regular		1746	H min 11.110 max 11.117 mean 11.114
1673	Negutai	GPU 64 COO min 3.500 max* 3.540 mean 3.501	1747 Column-Gradient	III IIII II. II II III III III III III
1674		CSR min 11.860 max*13.100 mean 12.694	1748	GPU 64 COO min 6.590 max 6.710 mean 6.644
1675		H min 8.646 max 8.646 mean 8.646	1749	CSR min 9.400 max 13.140 mean 9.991
1676	Row-Premute		1750	H min 12.040 max*12.046 mean 12.043
1677		GPU 64 COO min 3.360 max 3.370 mean 3.365	1751 Row-Column-Permute	
1678		CSR min 6.210 max 7.610 mean 6.631	1752	GPU 64 COO min 6.640 max 6.710 mean 6.679
1679		H min 11.027 max 11.032 mean 11.030	1753	CSR min 9.690 max 10.740 mean 10.050
1680	Row-Gradient		1754	H min 11.874 max 11.877 mean 11.875
1681		GPU 64 COO min 3.370 max 3.380 mean 3.376	1755 OPF_3754.mtx	
1682		CSR min 6.170 max 7.070 mean 6.499	1756 Regular	
1683		H min 11.059 max 11.068 mean 11.064	1757	GPU 64 COO min 4.430 max* 4.450 mean 4.443
			1758	CSR min 9.710 max*13.000 mean 11.377
1684	Column-Gradient			
1684 1685	Column-Gradient	GPU 64 COO min 3.350 max 3.390 mean 3.371	1759	H min 8.393 max 8.393 mean 8.393
	Column-Gradient	GPU 64 COO min 3.350 max 3.390 mean 3.371 CSR min 6.150 max 7.180 mean 6.531	1759 1760 Row-Premute	H min 8.393 max 8.393 mean 8.393
1685	Column-Gradient			H min 8.393 max 8.393 mean 8.393 GPU 64 COO min 4.230 max 4.250 mean 4.240
1685 1686	Column-Gradient Row-Column-Permute	CSR min 6.150 max 7.180 mean 6.531	1760 Row-Premute	
1685 1686 1687		CSR min 6.150 max 7.180 mean 6.531	1760 Row-Premute 1761	GPU 64 COO min 4.230 max 4.250 mean 4.240
1685 1686 1687 1688		CSR min 6.150 max 7.180 mean 6.531 H min 11.125 max*11.133 mean 11.130	1760 Row-Premute 1761 1762	GPU 64 COO min 4.230 max 4.250 mean 4.240 CSR min 7.430 max 8.750 mean 7.986
1685 1686 1687 1688 1689		CSR min 6.150 max 7.180 mean 6.531 H min 11.125 max*11.133 mean 11.130 GPU 64 COO min 3.350 max 3.380 mean 3.364	1760 Row-Premute 1761 1762 1763	GPU 64 COO min 4.230 max 4.250 mean 4.240 CSR min 7.430 max 8.750 mean 7.986
1685 1686 1687 1688 1689 1690		CSR min 6.150 max 7.180 mean 6.531 H min 11.125 max*11.133 mean 11.130 GPU 64 COO min 3.350 max 3.380 mean 3.364 CSR min 6.040 max 7.440 mean 6.603	1760 Row-Premute 1761 1762 1763 1764 Row-Gradient	GPU 64 COO min 4.230 max 4.250 mean 4.240 CSR min 7.430 max 8.750 mean 7.986 H min 11.266 max 11.272 mean 11.269
1685 1686 1687 1688 1689 1690	Row-Column-Permute	CSR min 6.150 max 7.180 mean 6.531 H min 11.125 max*11.133 mean 11.130 GPU 64 COO min 3.350 max 3.380 mean 3.364 CSR min 6.040 max 7.440 mean 6.603	1760 Row-Premute 1761 1762 1763 1764 Row-Gradient 1765	GPU 64 COO min 4.230 max 4.250 mean 4.240 CSR min 7.430 max 8.750 mean 7.986 H min 11.266 max 11.272 mean 11.269 GPU 64 COO min 4.370 max 4.420 mean 4.382
1685 1686 1687 1688 1689 1690 1691	Row-Column-Permute	CSR min 6.150 max 7.180 mean 6.531 H min 11.125 max*11.133 mean 11.130 GPU 64 COO min 3.350 max 3.380 mean 3.364 CSR min 6.040 max 7.440 mean 6.603	1760 Row-Premute 1761 1762 1763 1764 Row-Gradient 1765	GPU 64 COO min 4.230 max 4.250 mean 4.240 CSR min 7.430 max 8.750 mean 7.986 H min 11.266 max 11.272 mean 11.269 GPU 64 COO min 4.370 max 4.420 mean 4.382 CSR min 8.160 max 9.470 mean 8.682
1685 1686 1687 1688 1689 1690 1691 1692 1693	Row-Column-Permute	CSR min 6.150 max 7.180 mean 6.531 H min 11.125 max*11.133 mean 11.130 GPU 64 COO min 3.350 max 3.380 mean 3.364 CSR min 6.040 max 7.440 mean 6.603 H min 11.028 max 11.033 mean 11.030	1760 Row-Premute 1761 1762 1763 1764 Row-Gradient 1765 1766	GPU 64 COO min 4.230 max 4.250 mean 4.240 CSR min 7.430 max 8.750 mean 7.986 H min 11.266 max 11.272 mean 11.269 GPU 64 COO min 4.370 max 4.420 mean 4.382 CSR min 8.160 max 9.470 mean 8.682

1770		CCD 7 160 0 000 7 505	1844 Day Daamuta	
1770		CSR min 7.160 max 8.080 mean 7.595	1844 Row-Premute	CDU C4 COO/- 10 240 10 420 10 262
1771		H min 11.394 max*11.401 mean 11.398	1845	GPU 64 COO min 10.340 max 10.430 mean 10.362
1772	Row-Column-Permute		1846	CSR min 12.880 max 13.340 mean 13.057
1773		GPU 64 COO min 4.230 max 4.250 mean 4.243	1847	H min 10.777 max 10.778 mean 10.777
1774		CSR min 7.230 max 8.940 mean 8.056	1848 Row-Gradient	
1775		H min 11.264 max 11.271 mean 11.269	1849	GPU 64 COO min 10.650 max*10.740 mean 10.688
1776	c-47.mtx		1850	CSR min 12.310 max 13.670 mean 12.562
1777	Regular		1851	H min 11.247 max 11.300 mean 11.281
1778		GPU 64 COO min 5.320 max* 5.340 mean 5.329	1852 Column-Gradient	
1779		CSR min 8.890 max* 9.590 mean 9.249	1853	GPU 64 COO min 10.340 max 10.440 mean 10.398
1780		H min 8.364 max 8.364 mean 8.364	1854	CSR min 9.480 max 10.110 mean 9.782
1781	Row-Premute		1855	H min 12.023 max*12.069 mean 12.047
1782		GPU 64 COO min 5.240 max 5.250 mean 5.241	1856 Row-Column-Permute	
1783		CSR min 7.790 max 8.890 mean 8.214	1857	GPU 64 COO min 10.330 max 10.380 mean 10.356
1784		H min 10.059 max 10.063 mean 10.061	1858	CSR min 12.840 max 13.530 mean 13.119
1785	Row-Gradient	ii iii io.oos iida io.oos iidai io.oo	1859	H min 10.776 max 10.778 mean 10.777
1786	NOW Gradient	GPU 64 COO min 5.230 max 5.260 mean 5.242	1860 aft01.mtx	11 III 10.770 IIIAX 10.770 IIICAN 10.777
		CSR min 7.080 max 8.050 mean 7.673		
1787			1861 Regular	
1788		H min 10.206 max 10.226 mean 10.218	1862	GPU 64 COO min 3.680 max* 3.690 mean 3.688
1789	Column-Gradient		1863	CSR min 13.860 max*14.830 mean 14.560
1790		GPU 64 COO min 5.080 max 5.120 mean 5.105	1864	H min 7.811 max 7.811 mean 7.811
1791		CSR min 5.780 max 6.970 mean 6.359	1865 Row-Premute	
1792		H min 11.205 max*11.233 mean 11.222	1866	GPU 64 COO min 3.510 max 3.530 mean 3.513
1793	Row-Column-Permute		1867	CSR min 6.420 max 10.520 mean 7.265
1794		GPU 64 COO min 5.220 max 5.250 mean 5.227	1868	H min 11.161 max*11.170 mean 11.165
1795		CSR min 7.860 max 8.710 mean 8.247	1869 Row-Gradient	
1796		H min 10.059 max 10.064 mean 10.061	1870	GPU 64 COO min 3.630 max 3.670 mean 3.643
1797	mhd4800a.mtx		1871	CSR min 10.760 max 13.510 mean 12.199
1798	Regular		1872	H min 10.248 max 10.265 mean 10.258
1799	Regulai	GPU 64 COO min 3.090 max* 3.100 mean 3.098	1873 Column-Gradient	11 III11 10.246 IIIAX 10.203 IIIEAII 10.236
1800		CSR min 11.570 max*12.290 mean 12.092	1874	GPU 64 COO min 3.510 max 3.520 mean 3.519
1801		H min 7.132 max 7.132 mean 7.132	1875	CSR min 6.490 max 11.230 mean 7.645
1802	Row-Premute		1876	H min 11.112 max 11.121 mean 11.117
1803		GPU 64 COO min 3.020 max 3.020 mean 3.020	1877 Row-Column-Permute	
1804		CSR min 5.560 max 7.270 mean 6.007	1878	GPU 64 COO min 3.510 max 3.540 mean 3.515
1805		H min 10.959 max*10.968 mean 10.963	1879	CSR min 6.510 max 11.650 mean 7.311
1806	Row-Gradient		1880	H min 11.161 max 11.168 mean 11.165
1807		GPU 64 COO min 3.080 max 3.100 mean 3.088	1881 TSOPF_RS_b39_c7.mtx	
1808		CSR min 10.250 max 12.150 mean 11.340	1882 Regular	
1809		H min 9.509 max 9.528 mean 9.520	1883	GPU 64 COO min 5.970 max* 6.010 mean 5.988
1810	Column-Gradient		1884	CSR min 12.470 max*21.120 mean 13.816
1811	column or dulcine	GPU 64 COO min 3.020 max 3.050 mean 3.026	1885	H min 7.304 max 7.304 mean 7.304
1812		CSR min 5.530 max 10.580 mean 6.432	1886 Row-Premute	11 IIII 7.304 IIIAX 7.304 IIICAII 7.304
		H min 10.933 max 10.946 mean 10.939	1887	CDU 64 COO E 940 E 970 E 966
1813	D	n min 10.933 max 10.946 mean 10.939		GPU 64 COO min 5.840 max 5.870 mean 5.856
1814	Row-Column-Permute		1888	CSR min 10.780 max 15.810 mean 11.425
1815		GPU 64 COO min 3.020 max 3.020 mean 3.020	1889	H min 10.537 max 10.540 mean 10.539
1816		CSR min 5.510 max 6.830 mean 6.136	1890 Row-Gradient	
1817		H min 10.959 max 10.967 mean 10.963	1891	GPU 64 COO min 5.950 max 6.000 mean 5.975
1818	gen4.mtx		1892	CSR min 11.520 max 17.250 mean 12.799
1819	Regular		1893	H min 9.638 max 9.646 mean 9.641
1820		GPU 64 COO min 3.300 max* 3.320 mean 3.308	1894 Column-Gradient	
1821		CSR min 5.250 max 6.340 mean 5.705	1895	GPU 64 COO min 5.790 max 5.860 mean 5.827
1822		H min 9.234 max 9.234 mean 9.234	1896	CSR min 10.500 max 14.080 mean 11.237
1823	Row-Premute		1897	H min 11.128 max*11.223 mean 11.209
1824		GPU 64 COO min 3.290 max 3.310 mean 3.299	1898 Row-Column-Permute	
1825		CSR min 5.190 max 7.420 mean 5.683	1899	GPU 64 COO min 5.850 max 5.870 mean 5.855
1826		H min 10.249 max 10.254 mean 10.252	1900	CSR min 10.790 max 15.250 mean 11.718
	Pow-Cradient	11 IIII 10.243 IIIAX 10.234 IIICAN 10.232		
1827	Row-Gradient	CDII 64 COO 2 200 2 222 2 222	1901	H min 10.537 max 10.541 mean 10.539
1828		GPU 64 COO min 3.300 max 3.310 mean 3.301	1902 mult_dcop_03.mtx	
1829		CSR min 5.370 max 6.310 mean 5.659	1903 Regular	
1830		H min 9.934 max 9.958 mean 9.948	1904	GPU 64 COO min 5.130 max* 5.220 mean 5.142
1831	Column-Gradient		1905	CSR min 7.250 max* 9.320 mean 7.722
1832		GPU 64 COO min 3.240 max 3.260 mean 3.249	1906	H min 9.689 max 9.689 mean 9.689
1833		CSR min 5.090 max* 8.660 mean 5.546	1907 Row-Premute	
1834		H min 10.853 max*10.873 mean 10.864	1908	GPU 64 COO min 4.980 max 5.030 mean 4.999
1835	Row-Column-Permute		1909	CSR min 6.460 max 8.470 mean 6.950
1836		GPU 64 COO min 3.290 max 3.320 mean 3.296	1910	H min 10.738 max 10.742 mean 10.740
1837		CSR min 5.190 max 7.550 mean 5.659	1911 Row-Gradient	
1838		H min 10.249 max 10.255 mean 10.252	1912	GPU 64 COO min 5.070 max 5.140 mean 5.088
1839	Maragal_6.mtx	man 10.215 max 10.255 mean 10.252	1913	CSR min 6.780 max 8.700 mean 7.268
1840	Regular	CDU 64 000 -/- 10 F00 10 F00	1914	H min 10.572 max 10.584 mean 10.580
1841		GPU 64 COO min 10.580 max 10.620 mean 10.599	1915 Column-Gradient	
1842		CSR min 15.620 max*16.470 mean 15.832	1916	GPU 64 COO min 4.980 max 5.030 mean 5.010
1843		H min 9.930 max 9.930 mean 9.930	1917	CSR min 6.390 max 7.640 mean 6.982

```
| 1918 | H | min 10.825 max*10.845 man 10.836 | 1919 | Row-Column-Permute | 1920 | GPU 64 COO min | 4.990 max | 5.010 man | 4.997 | 1921 | CR min | 6.300 max | 7.160 man | 6.636 | 1922 | H | min | 10.738 max | 10.743 man | 10.740 man | 10.
```

REFERENCES

1923

1924

1925 1926

1928

1929

1930 1931

- [1] Hartwig Anzt, Terry Cojean, Chen Yen-Chen, Jack J. Dongarra, Goran Flegar, Pratik Nayak, Stanimire Tomov, Yuhsiang M. Tsai, and Weichung Wang. 2020. Load-balancing Sparse Matrix Vector Product Kernels on GPUs. ACM Trans. Parallel Comput. 7, 1 (2020), 2:1–2:26. https://doi.org/10.1145/3380930
- [2] Paolo D'Alberto, Chris Drome, and Ali Dasdan. 2012. Non-Parametric Methods Applied to the N-Sample Series Comparison. (2012). arXiv:stat.CO/1205.1880
- [3] Enver Kayaaslan, Cevdet Aykanat, and Bora Uçar. 2018. 1.5D Parallel
 Sparse Matrix-Vector Multiply. SIAM J. Scientific Computing 40, 1 (2018).
 https://doi.org/10.1137/16M1105591
- [4] Brian A. Page and Peter M. Kogge. 2018. Scalability of Hybrid Sparse
 Matrix Dense Vector (SpMV) Multiplication. In 2018 International Conference on High Performance Computing & Simulation, HPCS 2018, Orleans, France, July 16-20, 2018. IEEE, 406-414. https://doi.org/10.1109/
 HPCS.2018.00072