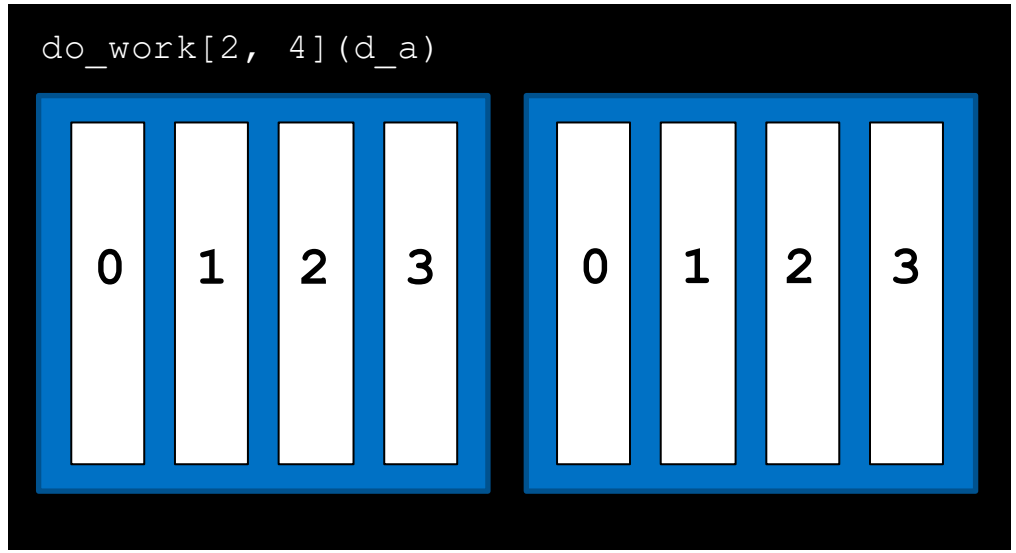
Grid-Stride Loops

GPU
DATA

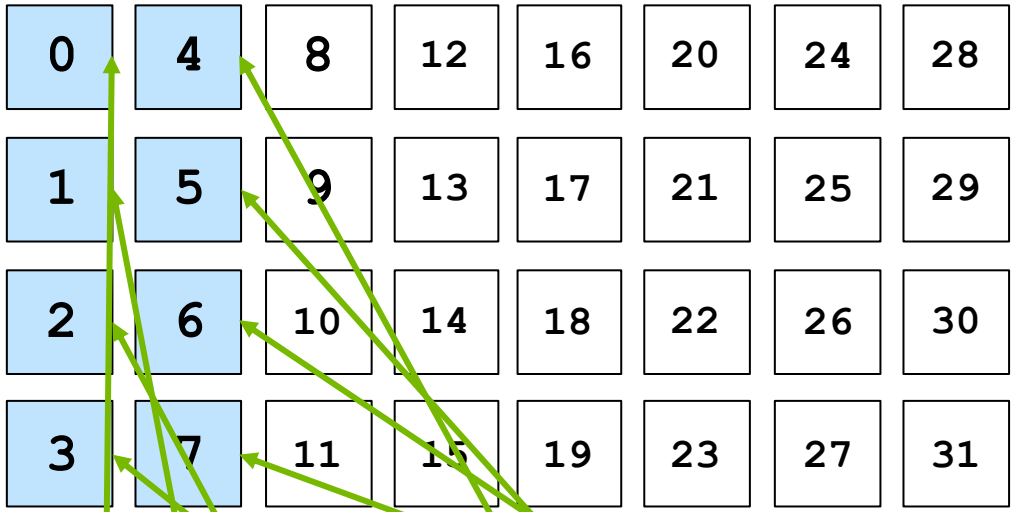
0	4	8	12	16	20	24	28
1	5	9	13	17	21	25	29
2	6	10	14	18	22	26	30
3	7	11	15	19	23	27	31

Often there are more data elements than there are threads in the grid

GPU

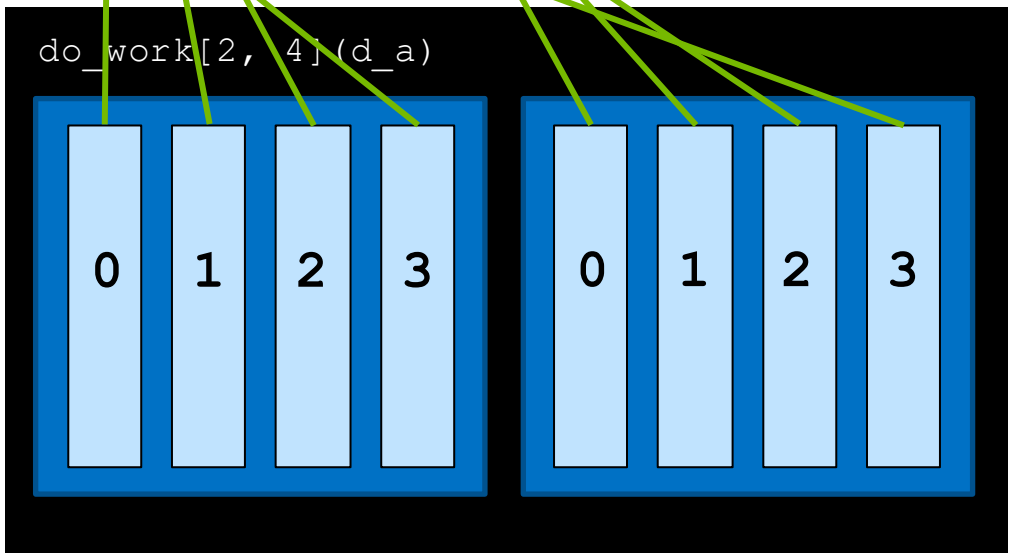


GPU
DATA



In such scenarios threads cannot work on only one element

GPU

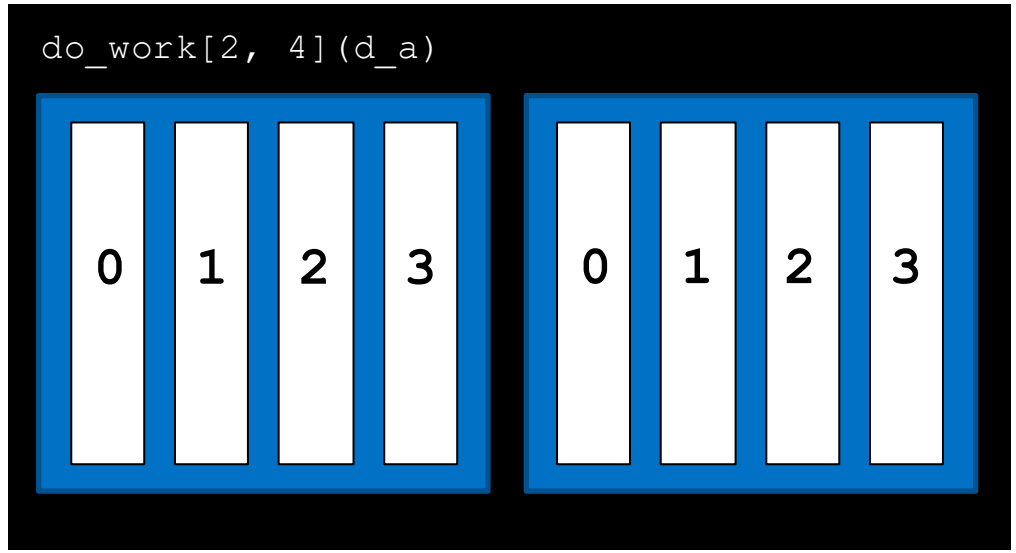


GPU
DATA

0	4	8	12	16	20	24	28
1	5	9	13	17	21	25	29
2	6	10	14	18	22	26	30
3	7	11	15	19	23	27	31

… or else work is left undone

GPU

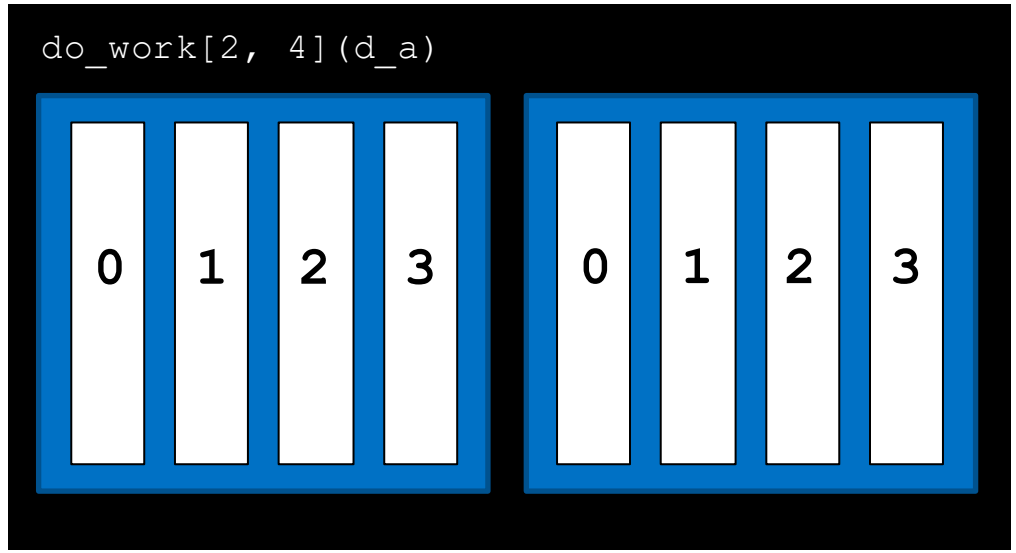


GPU
DATA

0	4	8	12	16	20	24	28
1	5	9	13	17	21	25	29
2	6	10	14	18	22	26	30
3	7	11	15	19	23	27	31

One way to address this programmatically is with a **grid-stride loop**

GPU

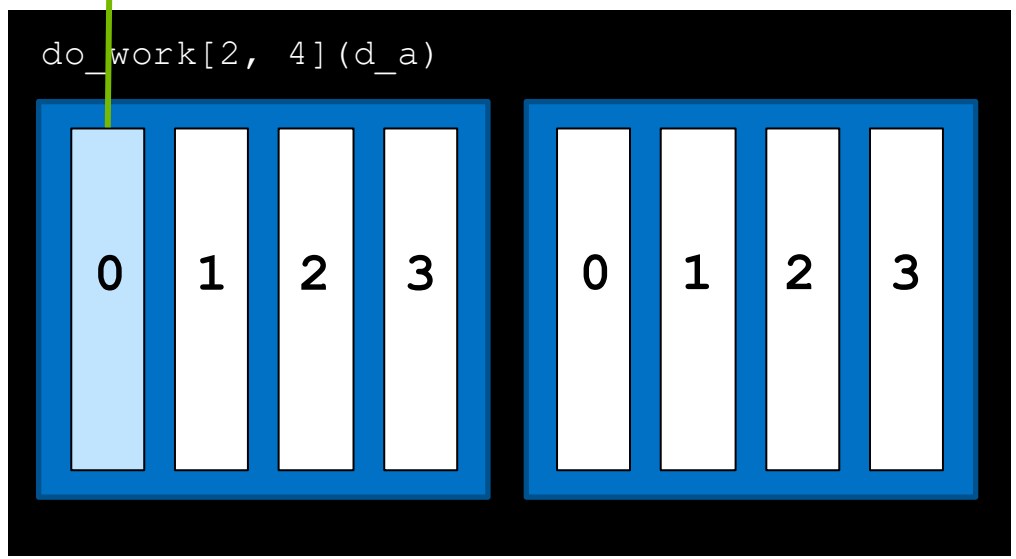


GPU
DATA

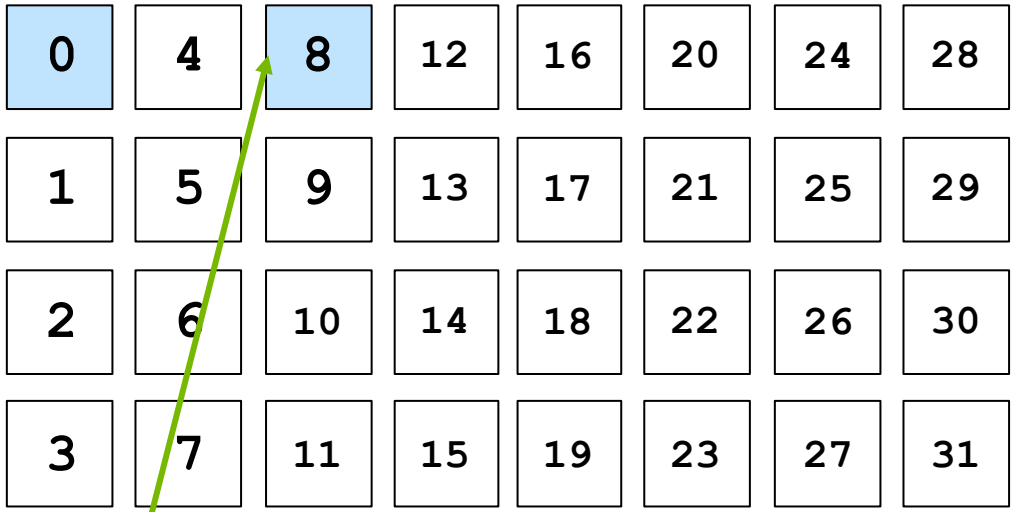
0	4	8	12	16	20	24	28
1	5	9	13	17	21	25	29
2	6	10	14	18	22	26	30
3	7	11	15	19	23	27	31

In a grid-stride loop, the thread's first element is calculated as usual, with **`cuda.grid()`**

GPU

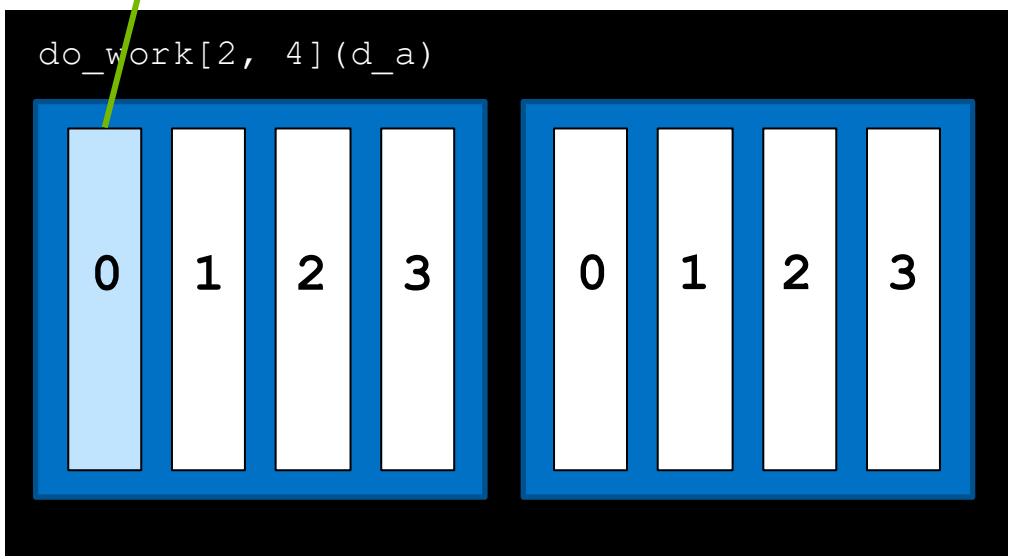


GPU
DATA

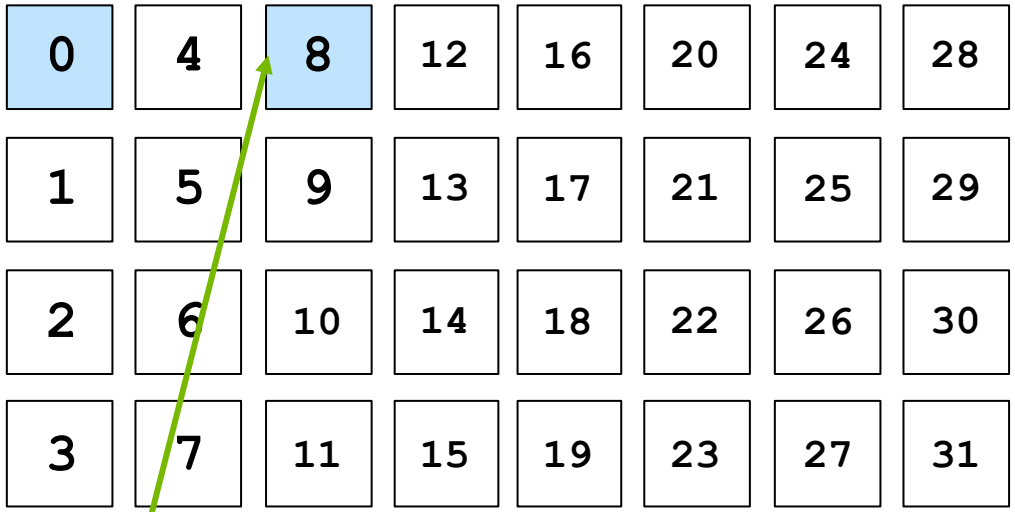


The thread then strides forward by the total number of threads in the grid (`blockDim.x * gridDim.x`), in this case 8

GPU

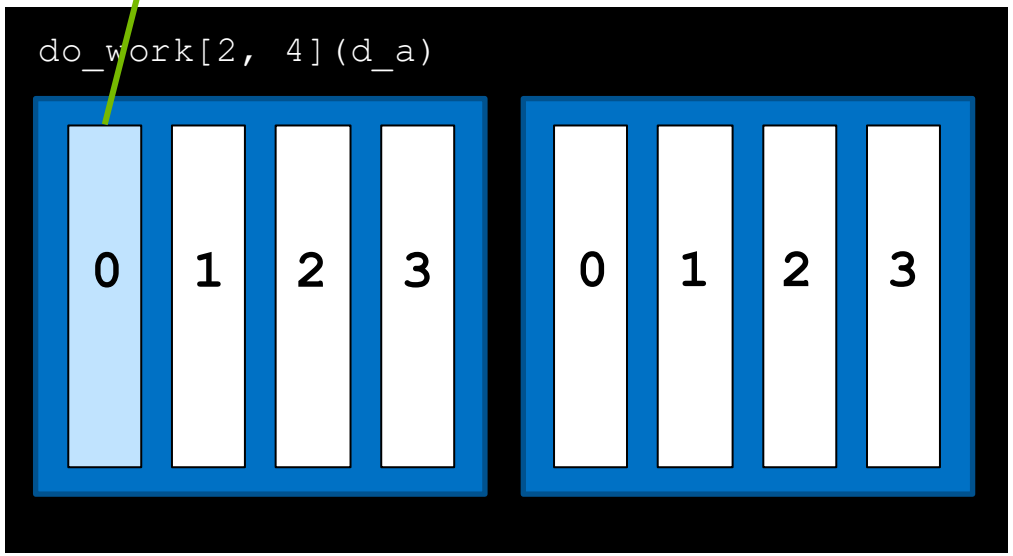


GPU
DATA



Numba provides another convenience function for this common calculation: **`cuda.gridsize()`**, returning the number of threads in the grid

GPU

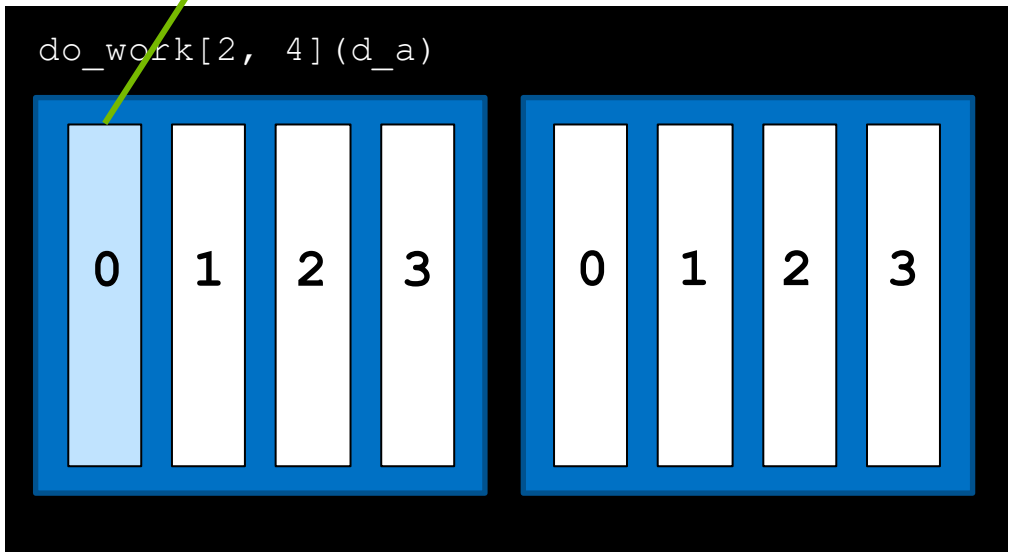


GPU
DATA

0	4	8	12	16	20	24	28
1	5	9	13	17	21	25	29
2	6	10	14	18	22	26	30
3	7	11	15	19	23	27	31

The thread continues in this way until its data index is greater than the number of data elements

GPU

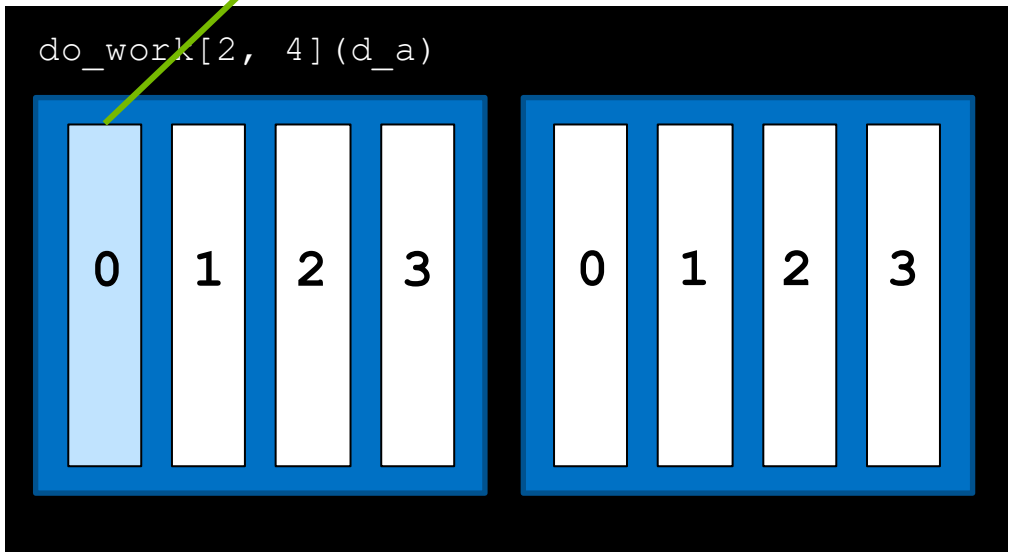


GPU
DATA

0	4	8	12	16	20	24	28
1	5	9	13	17	21	25	29
2	6	10	14	18	22	26	30
3	7	11	15	19	23	27	31

The thread continues in this way until its data index is greater than the number of data elements

GPU

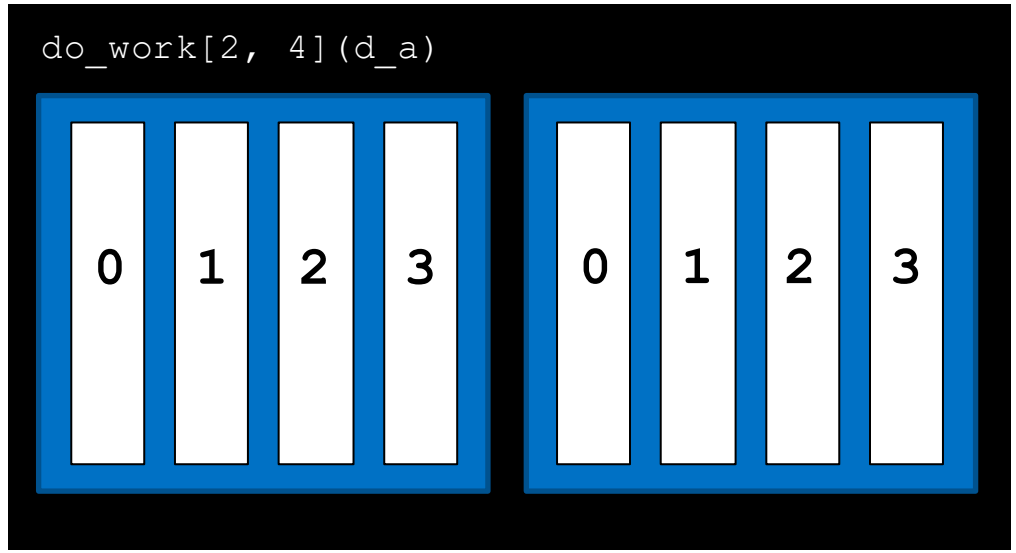


GPU
DATA

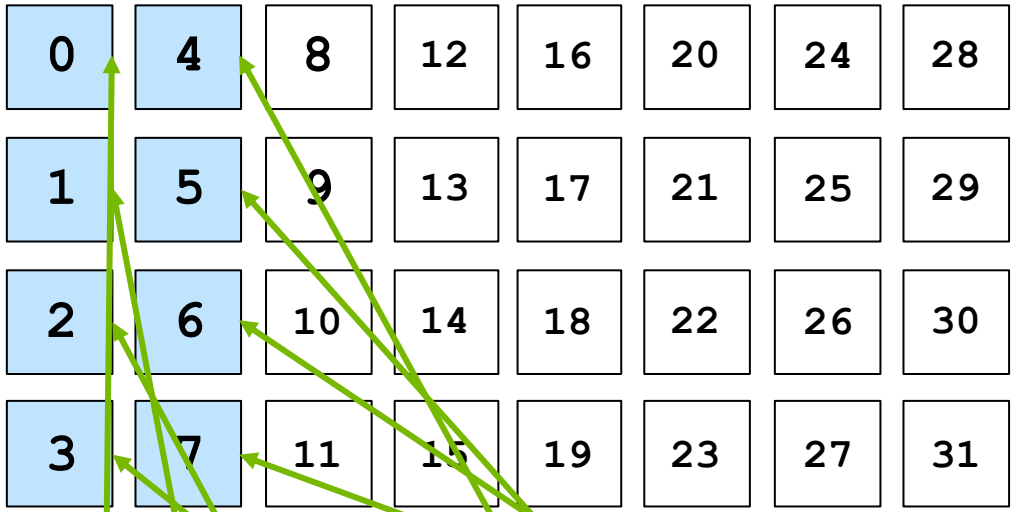
0	4	8	12	16	20	24	28
1	5	9	13	17	21	25	29
2	6	10	14	18	22	26	30
3	7	11	15	19	23	27	31

With all threads working in parallel using a grid stride loop...

GPU

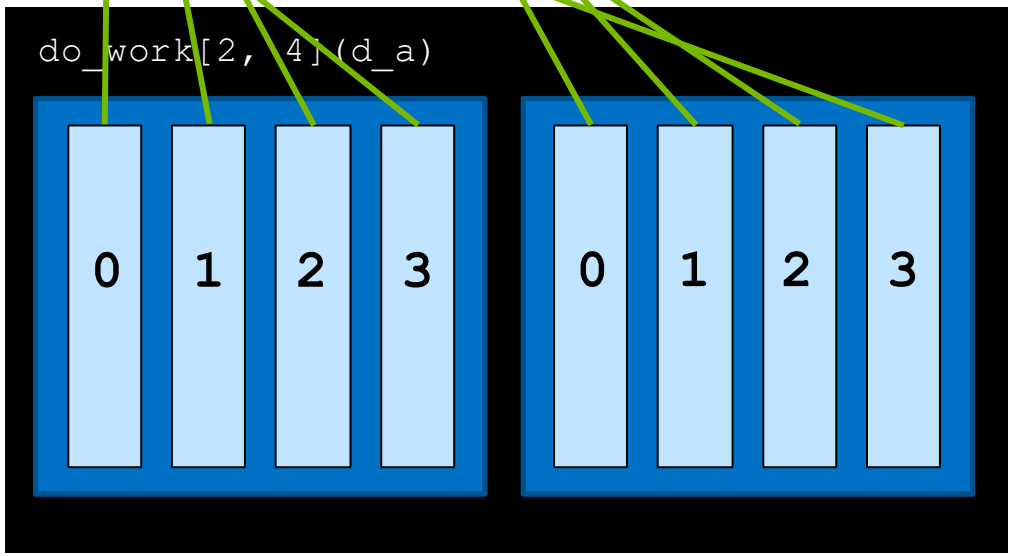


GPU
DATA

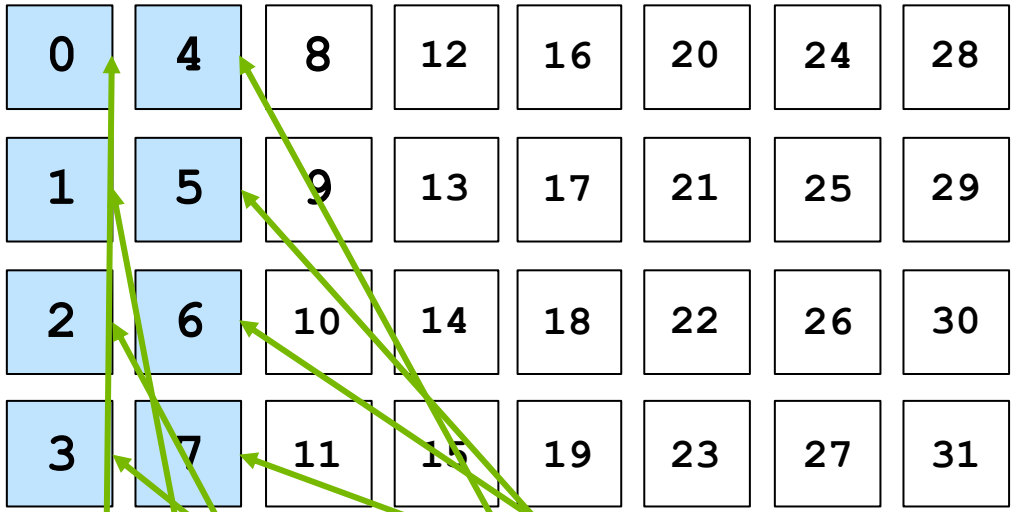


… all elements are covered

GPU

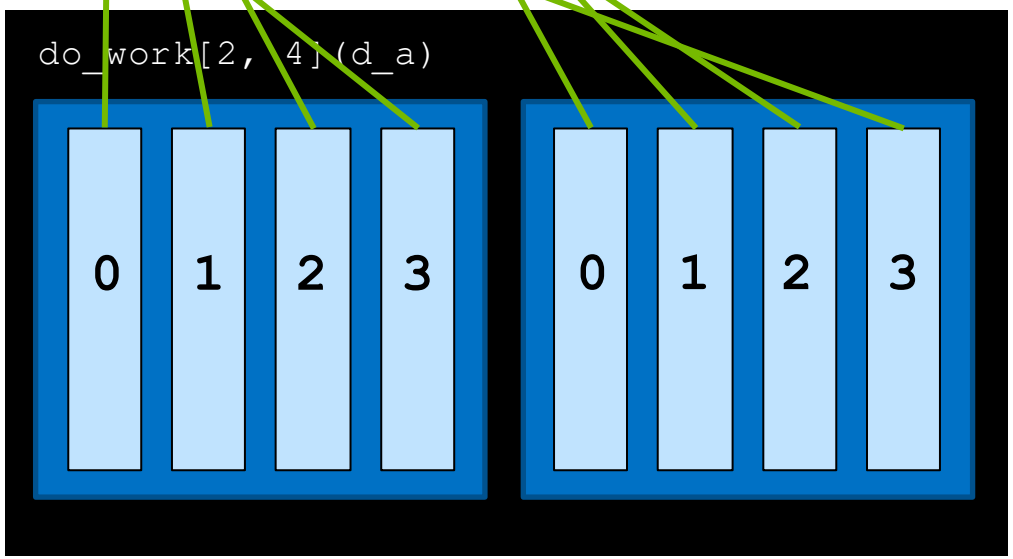


GPU
DATA

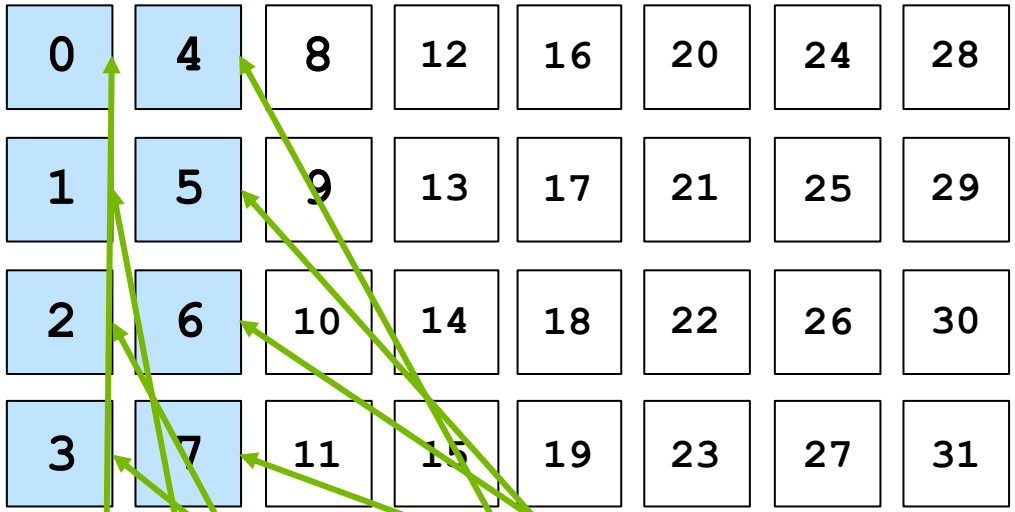


Additionally the device **coalesces** memory reads/writes into as few transactions as possible for performance...

GPU

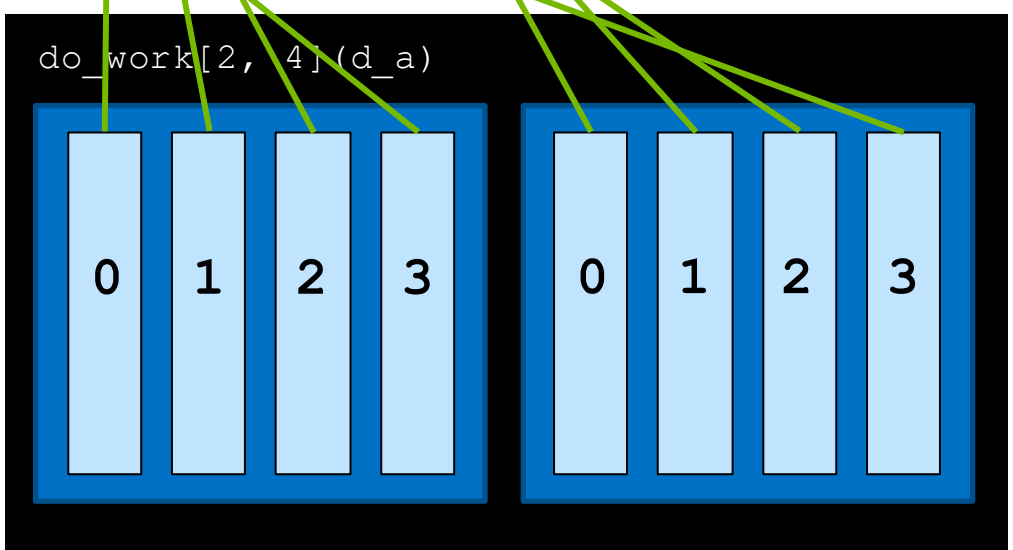


GPU
DATA



And grid stride loops support this **memory coalescing** because threads executing in parallel will access adjacent data elements

GPU



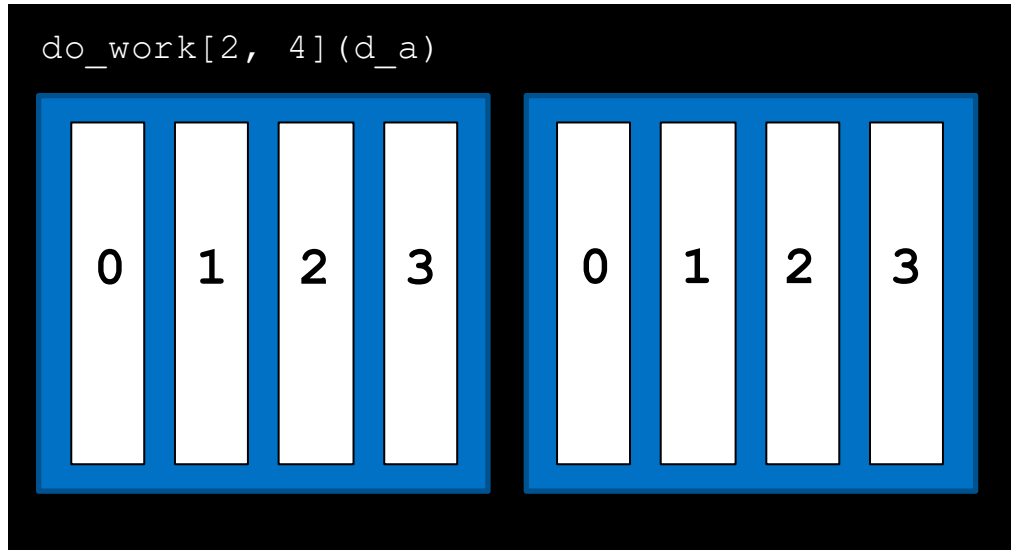
GPU
DATA

0	4	8	12	16	20	24	28
1	5	9	13	17	21	25	29
2	6	10	14	18	22	26	30
3	7	11	15	19	23	27	31

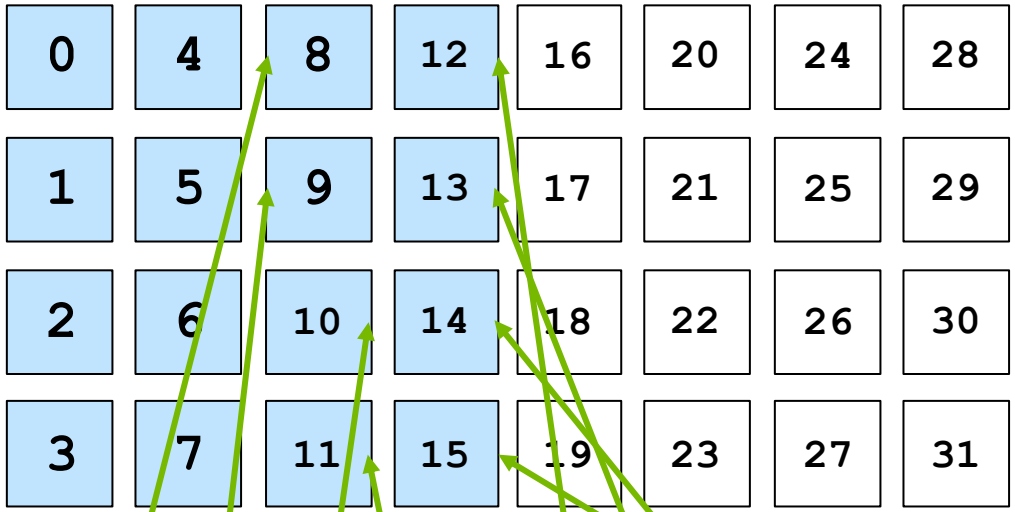
With all threads working in this way, all elements are covered with the performance advantage of memory coalescing

---

GPU

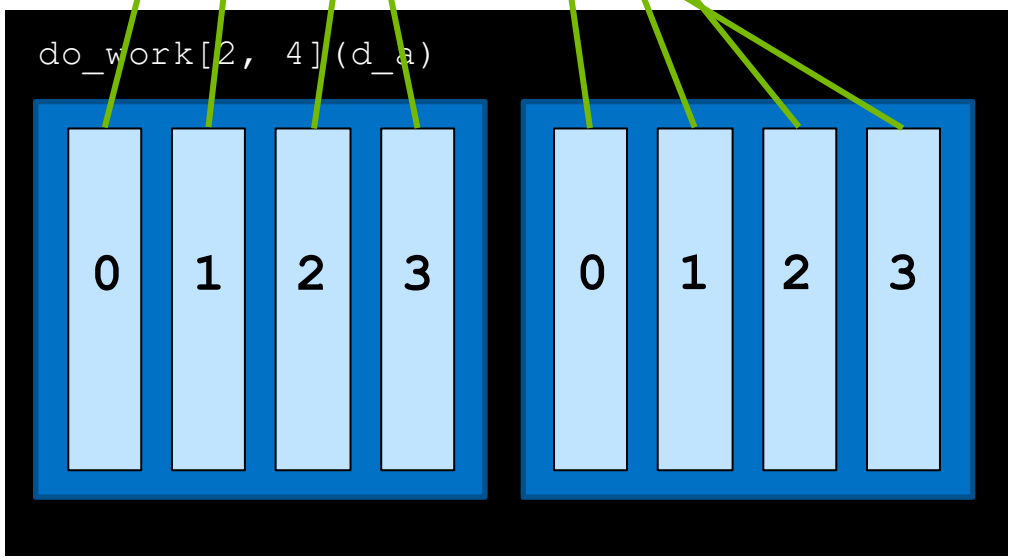


GPU
DATA



With all threads working in this way, all elements are covered with the performance advantage of memory coalescing

GPU



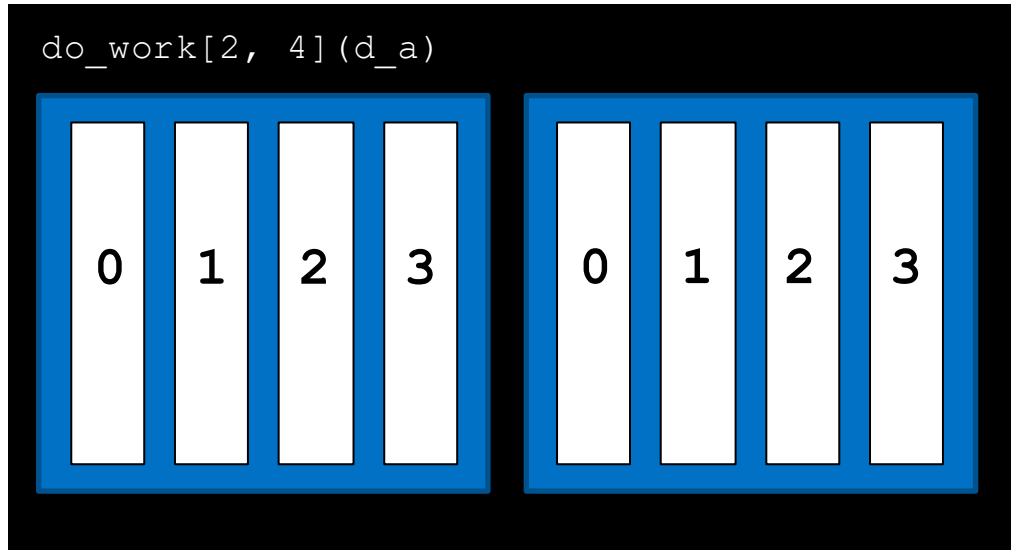
GPU
DATA

0	4	8	12	16	20	24	28
1	5	9	13	17	21	25	29
2	6	10	14	18	22	26	30
3	7	11	15	19	23	27	31

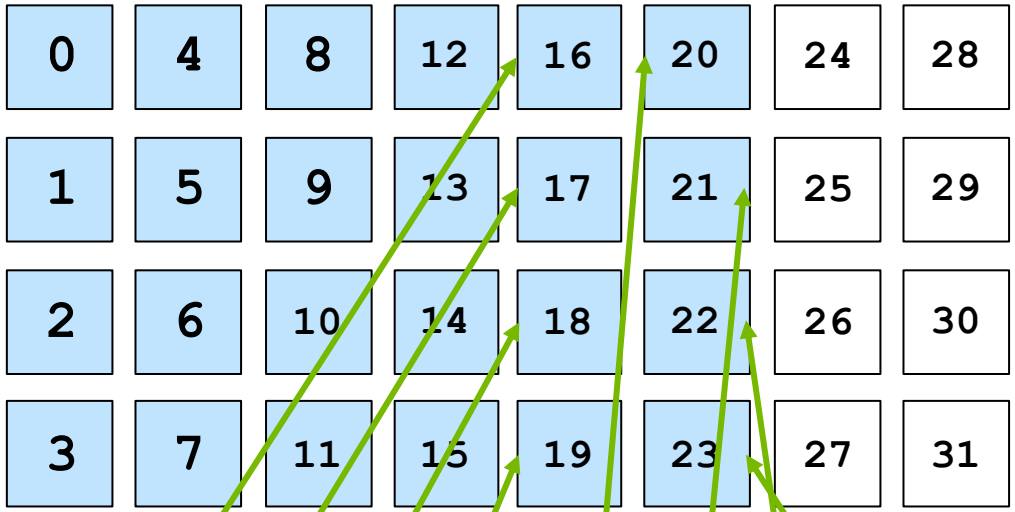
With all threads working in this way, all elements are covered with the performance advantage of memory coalescing

---

GPU

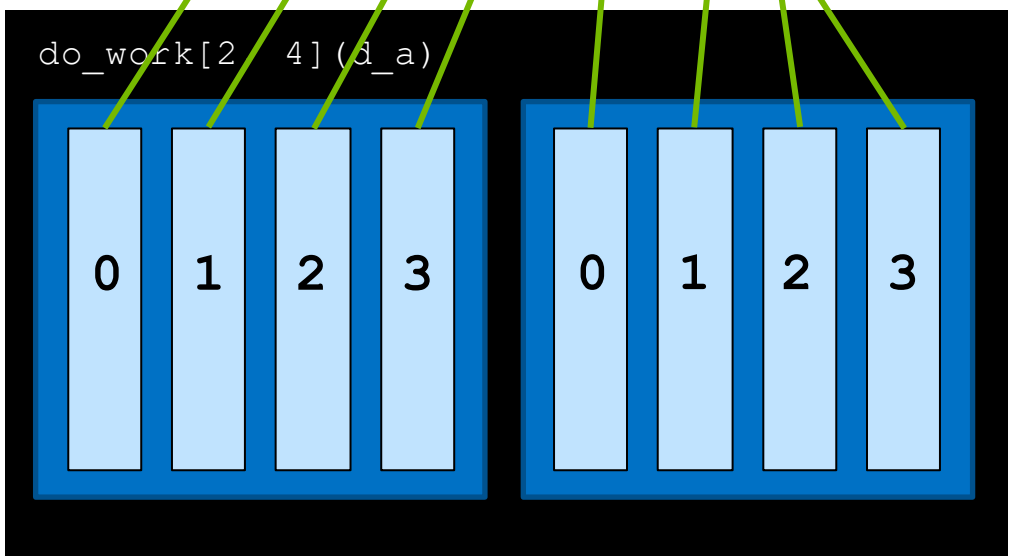


GPU
DATA



With all threads working in this way, all elements are covered with the performance advantage of memory coalescing

GPU



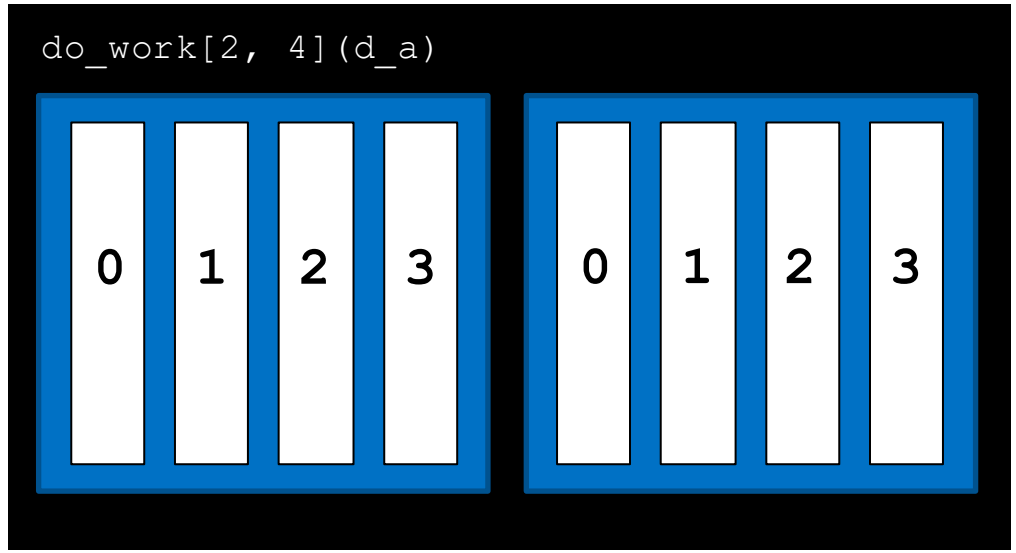
GPU
DATA

0	4	8	12	16	20	24	28
1	5	9	13	17	21	25	29
2	6	10	14	18	22	26	30
3	7	11	15	19	23	27	31

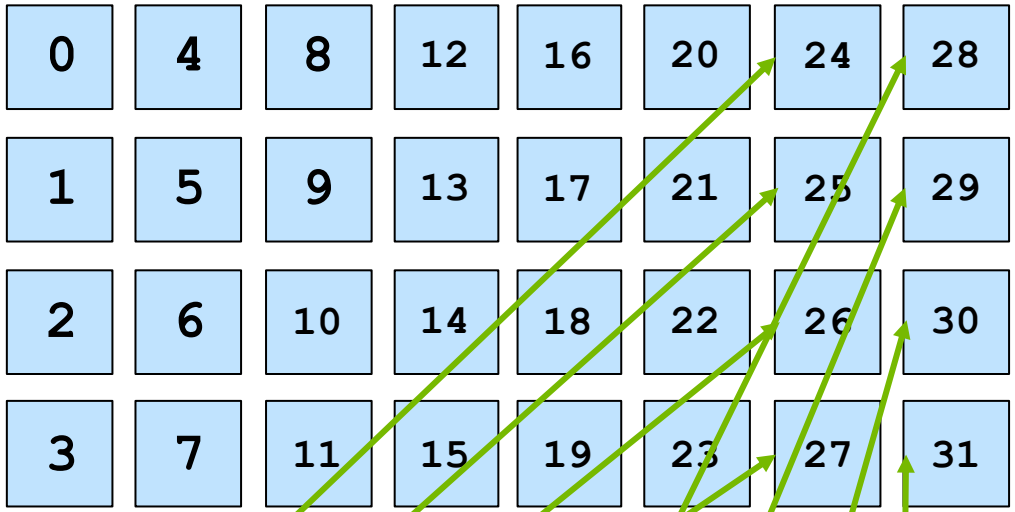
With all threads working in this way, all elements are covered with the performance advantage of memory coalescing

---

GPU

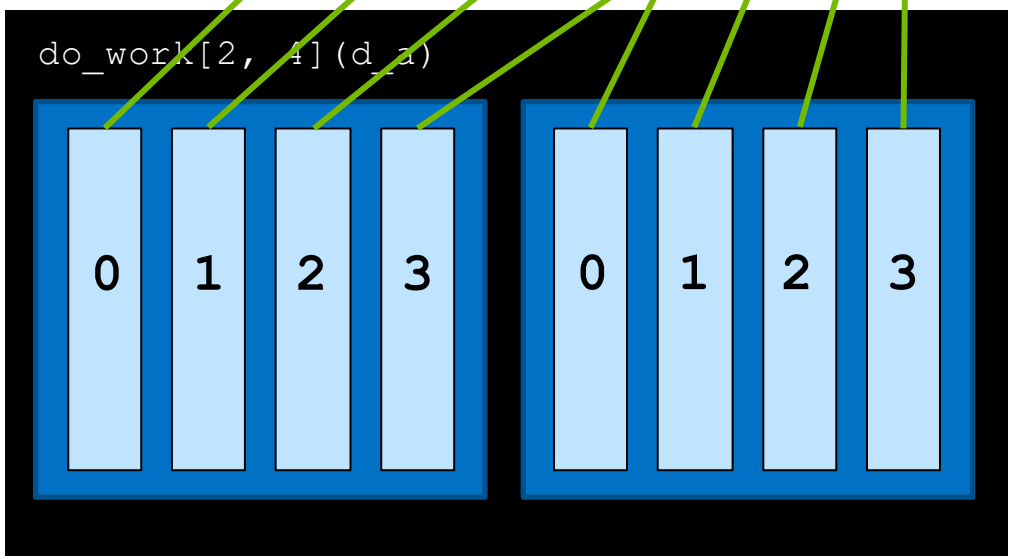


GPU
DATA



With all threads working in this way, all elements are covered with the performance advantage of memory coalescing

GPU



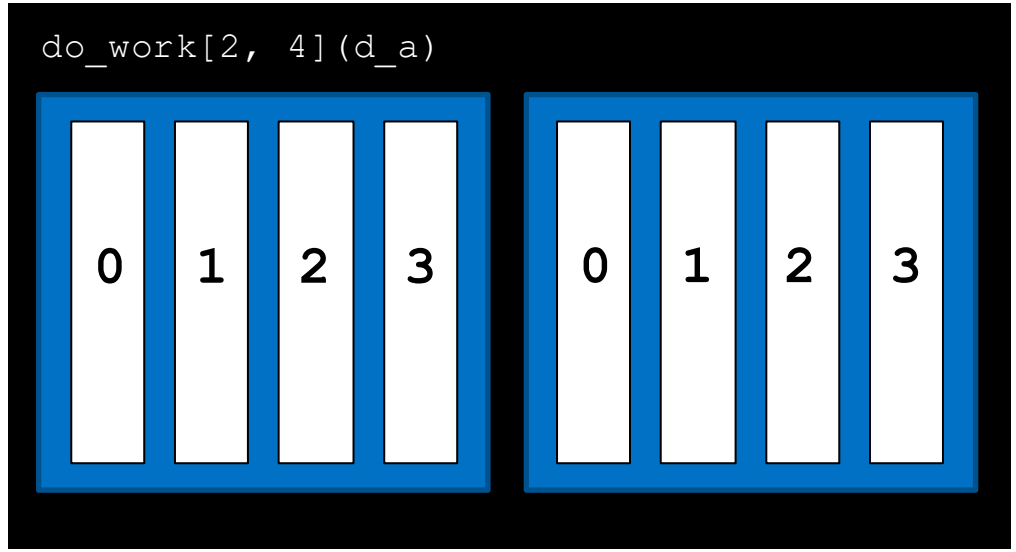
GPU
DATA

0	4	8	12	16	20	24	28
1	5	9	13	17	21	25	29
2	6	10	14	18	22	26	30
3	7	11	15	19	23	27	31

With all threads working in this way, all elements are covered with the performance advantage of memory coalescing

---

GPU



www.nvidia.com/dli