Lesson 16: Thread Hierarchy
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The “magic” Thread index

```cpp
template <typename Acc>
ALPAKA_FN_ACC void operator() (Acc const & acc) const {
    using namespace alpaka;

    uint32_t threadIdx = idx::getIdx<Grid, Threads>(acc)[0];
    printf("Hello, World from alpaka thread %u!\n", threadIdx);
}
```
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Understanding the index

• Understanding alpaka’s Thread indices is the key to understanding alpaka!

• After this lesson, you will understand:
  • How to navigate the grid
  • How to form Thread Blocks (and why)
  • The relations between Threads, Blocks and the Grid
  • How to compute Thread indices yourself
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Threads and the Grid

• A Grid consists of all Threads executing the same kernel → One Grid per Kernel execution

• Threads are distributed along one, two or three dimensions

• Each Thread on the Grid is identified by its unique index (gridThreadIdx)

• All Threads have access to (large but high-latency) global memory
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Thread Blocks

- Threads can be grouped into Thread Blocks
- All Blocks on the same Grid have the same size
- Each Block on the Grid is identified by its unique index (gridBlockIdx)
- Each Thread inside a Block is identified by its Block-local unique index (blockThreadIdx)
- Threads inside a Block have access to (small but low-latency) shared memory
- Threads inside a Block can be synchronized
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Obtaining the indices

- alpaka provides several API functions for obtaining indices:
  - Index of Thread on the Grid: `idx::getIdx<alpaka::Grid, alpaka::Threads>(acc)[dim];`
  - Index of Thread on a Block: `idx::getIdx<alpaka::Block, alpaka::Threads>(acc)[dim];`
  - Index of Block on the Grid: `idx::getIdx<alpaka::Grid, alpaka::Blocks>(acc)[dim];`

- You can also obtain the extents of the Grid or the Blocks:
  - Number of Threads on the Grid: `workdiv::getWorkDiv<alpaka::Grid, alpaka::Threads>(acc)[dim];`
  - Number of Threads on a Block: `workdiv::getWorkDiv<alpaka::Block, alpaka::Threads>(acc)[dim];`
  - Number of Blocks on the Grid: `workdiv::getWorkDiv<alpaka::Grid, alpaka::Blocks>(acc)[dim];`

- Exercise: compute the index of a Thread on the Grid yourself using a combination of the remaining indices and extents!