

Concurrency & Multi-Threading

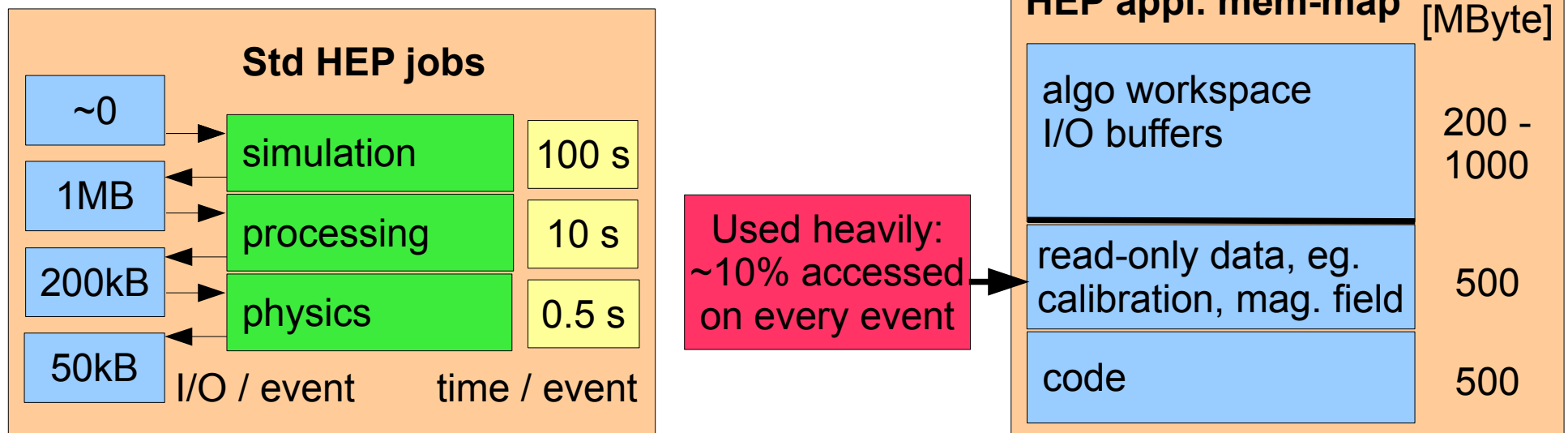
Matevž Tadel, ROOT project & ALICE experiment

Relevant activities at CERN:

- **OpenLab** – collaboration with industrial partners
- **Multi-Core R&D Project** – forum for experiments
- All computing projects – in one way or another

HEP event-data processing

- Several million events taken each day per experiment
- Events are independent – split them into jobs
 - 6 – 24 hours each
- Processes limited to 2 GByte, one process per core
 - standard CERN machine configuration



The threat of multi-core CPUs

- We were completely happy with that ...
but now we'll have to get our code parallelized.
- The goal:
Use CPU in full, reduce memory usage per core.
- It should be easy to reclaim 1 GByte per core.

Problem: our code was grown over 20+ years

- there is no real computation kernel;
- nobody thought about parallelization until now.

We can get by with our current model for a little longer ...

How we are coping with that

1. Use **memory page sharing** (OS / kernel tricks)
 - Keep processes as they are – this works best so far.
 - Shared-memory solution – **vtable ptr.** shared-lib problem (?)
2. ``Manual'' multi-threading
 - can parallelize on events or on their components:
ideally could use 100 – 1000 threads per event.
 - **I/O** and **heap management** become troublesome
we manage to efficiently use up to **~10 cores**.
3. **Compiler parallelization** of specialized algorithms
 - These take up **less than 10%** of a typical job
 - But there are cases where we have pure numerics

Questions

1. Memory management → should one bother with allocators / arenas or just use thread-aware malloc wrapper (e.g. Hoard)?
2. What happens with OpenMP? `async()` seems sufficient
3. No signal / floating-point exception handling.
Physics analysis → user-code that can do miracles.
4. `std::thread`
 - can one inherit from `std::thread` – could it be useful?
 - no cancellation, nor equivalent of `pthread_kill()`
 - detach invalidates thread ... why?
 - cleanup functions?