SAND2021-4666C

kokkos

Kokkos Tools Update

Business Sensitive Information

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EXASCALE COMPUTING PROJECT

Sandia National Laboratories

Argonne NATIONAL LABORATORY

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NNSA National Nuclear Security Administration

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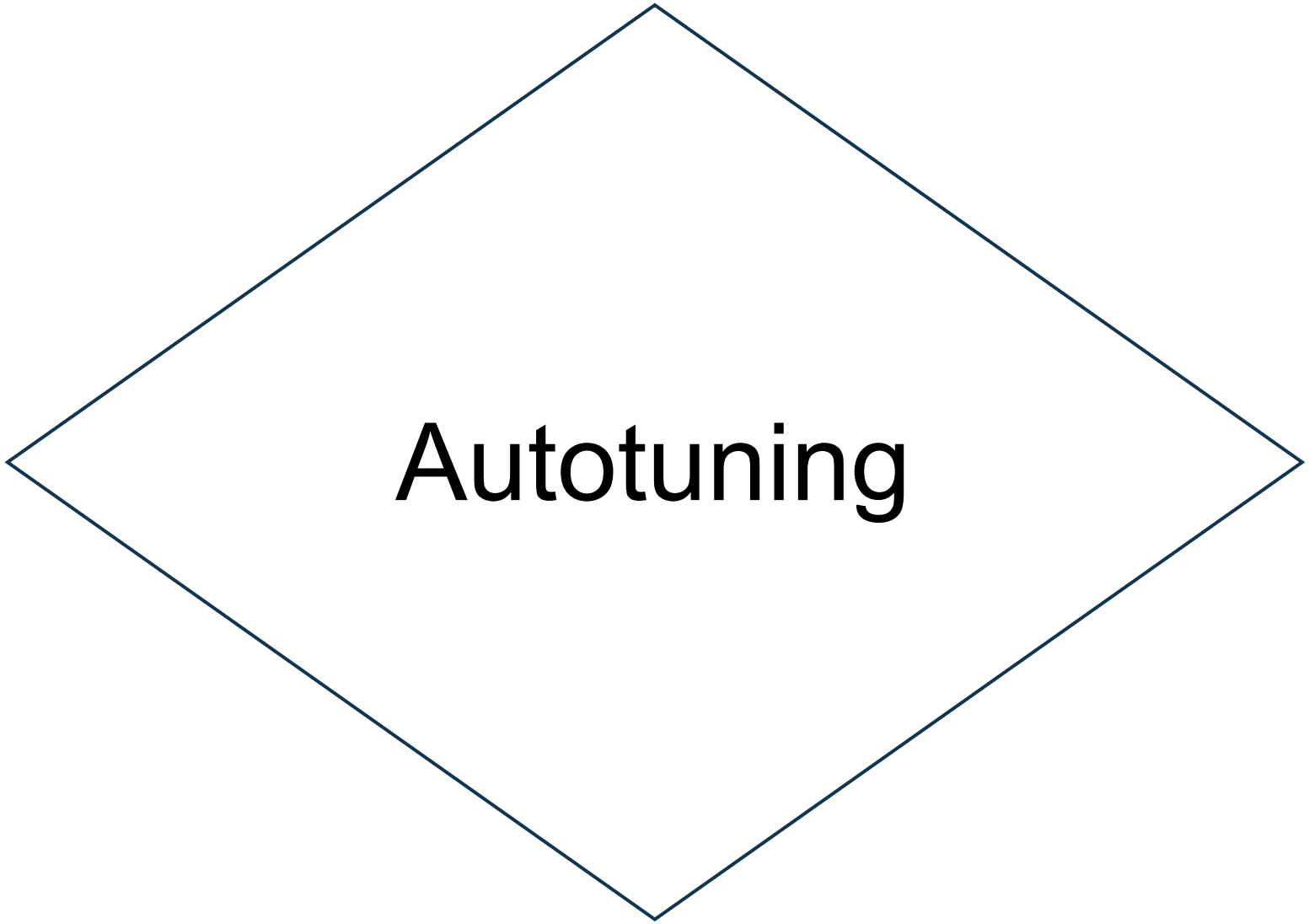
Another collaborative year!

Community project through and through


Autotuning

Why autotune?

The last 10-15% of performance in a Kokkos app comes from setting a few tuning knobs. These need to be maintained per:

Hardware: Intel, AMD, and NVIDIA GPU

Programming models: Serial, OpenMP, OpenMPTarget, CUDA, HIP, SYCL, Threads, HPX

Compilers: NVCC, Clang, GCC, vendor clang variants

How do you feel about maintaining that many heuristics?

Heuristics aren't feasible moving forward

Requirements: what can't we do?

- Recall from Profiling:
  - No recompilation
  - Applications can't *fail* if tools aren't available
  - No third-party dependencies in Kokkos
- Good news: there are many good tuning technologies in ECP we can use
- Bad news: there are *too many* good tuning technologies in ECP to pick one
- Answer: abstraction through a callback interface

Need to support a variety of tools, ECP has *depth* in this area

Based on our original tuner: Christian trott

- How does the Trott Tuner think about things like sparse matrix vector product?
  - What do I need to tune?
    - An implementation
    - Team sizes for my team policies
  - What might effect my choice?
    - Number of rows in the matrix
    - Sparsity
    - Backend I'm using
  - What options are valid?
    - Maybe a set, maybe a range?
  - Our autotuners need the information Christian has, provided formally

Need to support a variety of tools, ECP has *depth* in this area

App workflow: typical

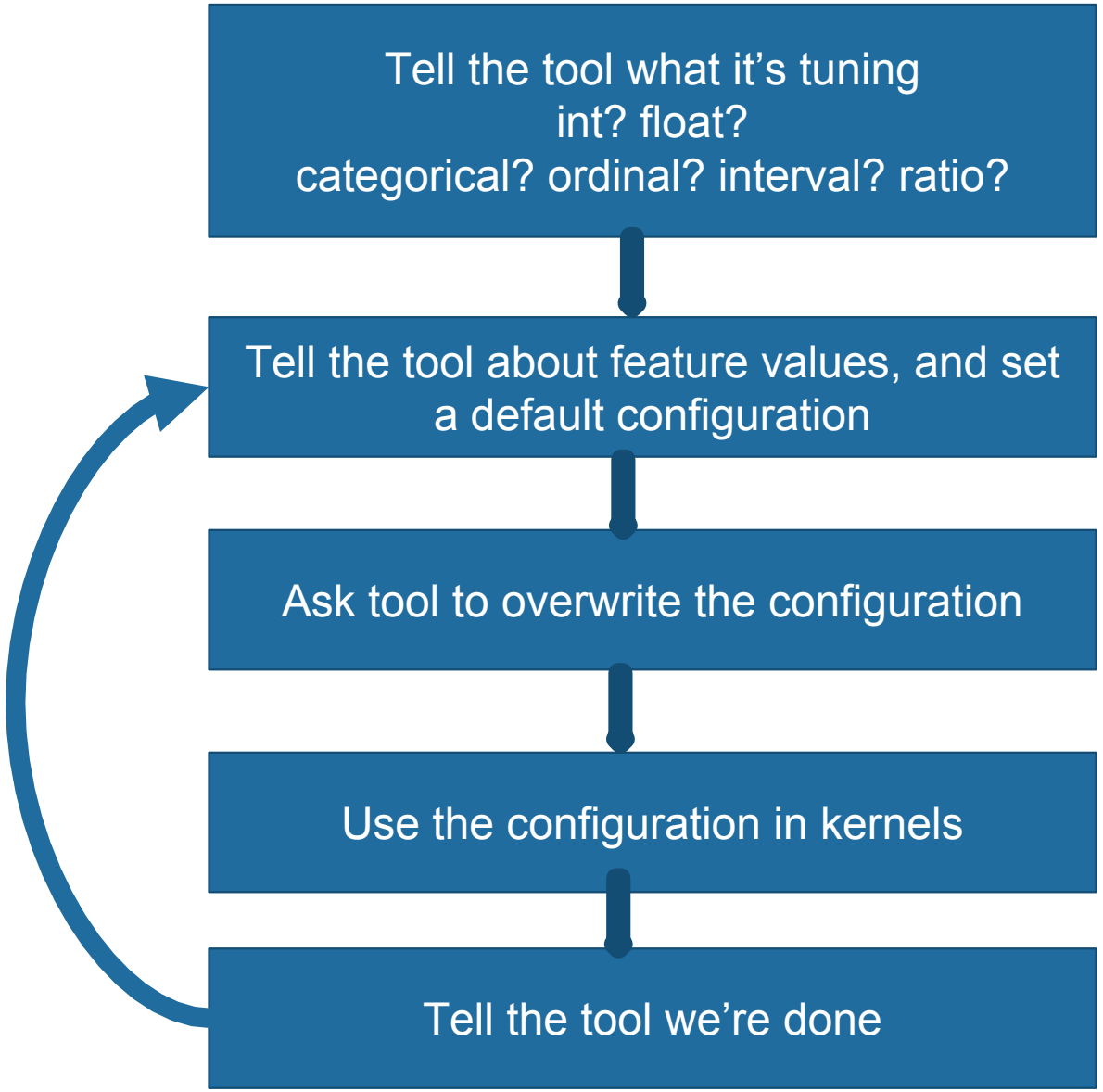
```
Kokkos::TeamPolicy<> policy(number_of_rows,
  Kokkos::AUTO,
  Kokkos::AUTO);

Kokkos::parallel_for(policy, /** ... */);
```

Absolute genius

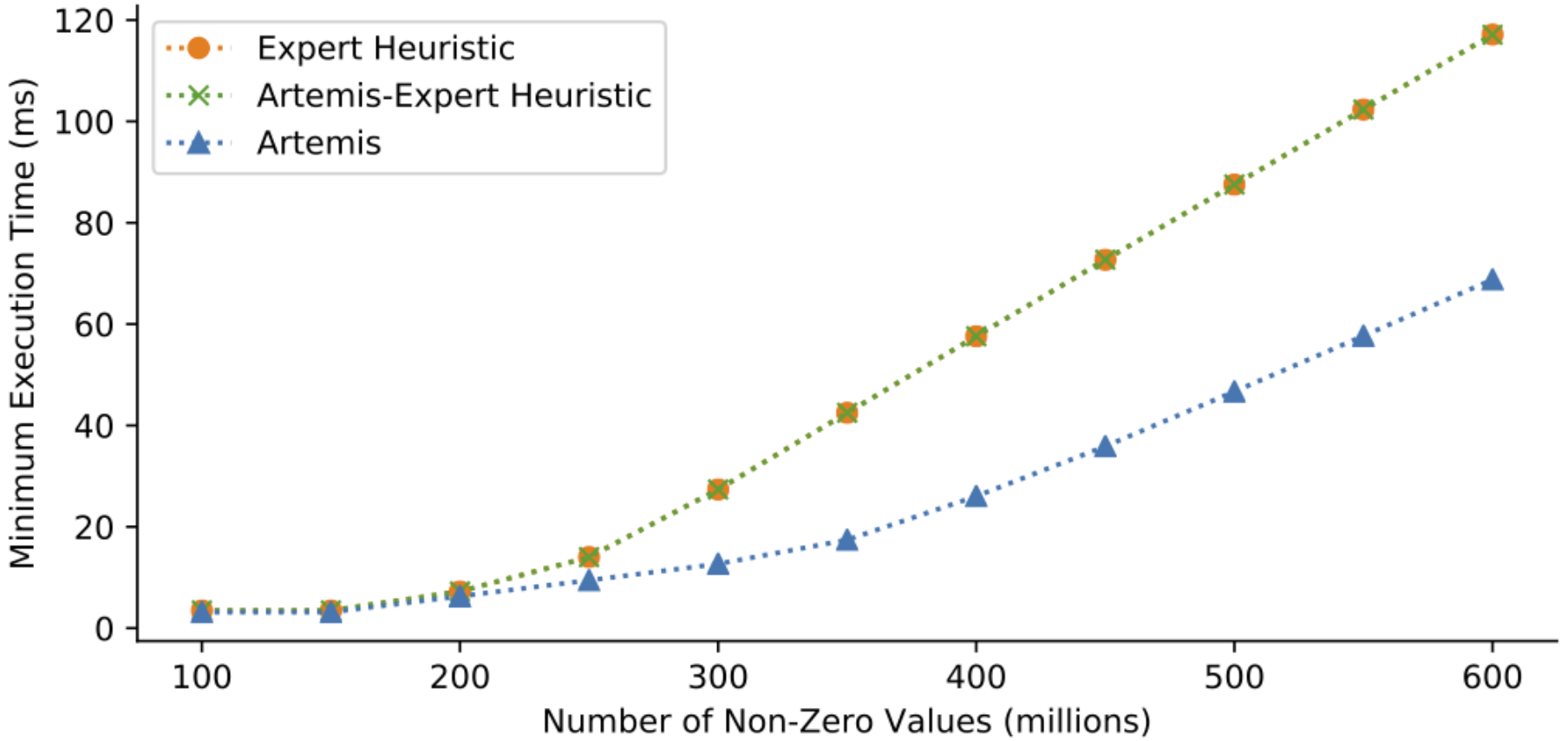
In most cases, code changes very little

App workflow: advanced



While app not done

Autotuning SPMV



Graph courtesy of Artemis team from LLNL and UO

Speedups on hand-tuned kernels. Reproduced with multiple tools


Performance
Tracking

Performance tracking: confident portable development

- Recently: CUDA performance on NVIDIA **priority one drop everything**
- Now: HIP or OpenMPTarget performance on AMD **priority one drop everything**
- Did your changes for HIP hurt your CUDA performance?
- Did *our* changes to HIP hurt your HIP performance?

- Solution survey:
  - SPOT
  - Watchr
  - LDMS
  - Dana
- Kokkos tools insulate you from betting your code on any one of these!

During frenetic development performance tracking *critical*

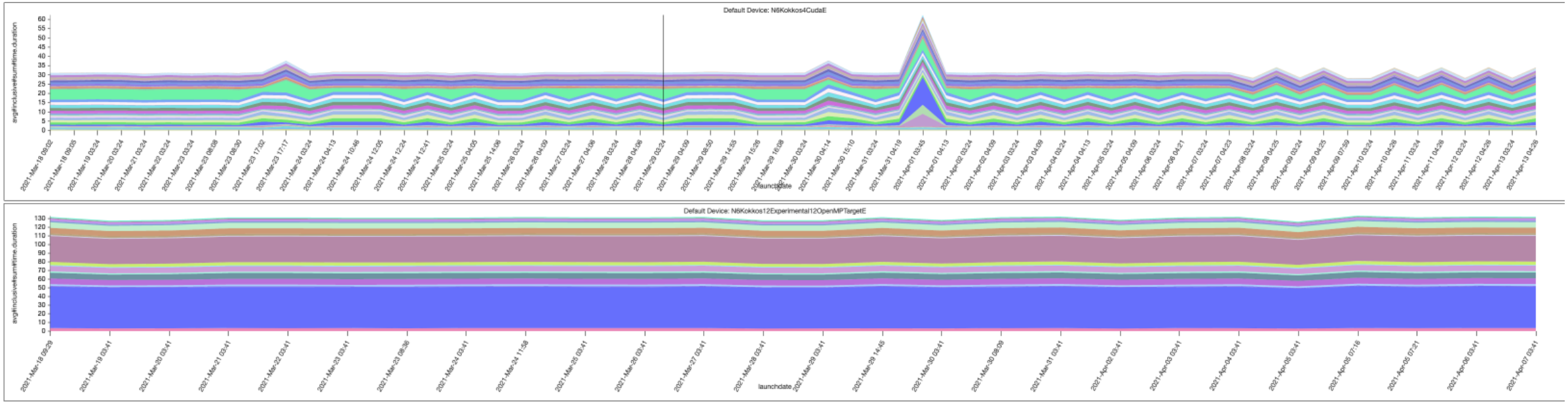
Code changes

```
Kokkos::Tools::declareMetadata("input_deck",
  input_deck);
Kokkos::Tools::declareMetadata("num_ranks",
  std::to_string(num_ranks));
Kokkos::Tools::pushRegion("region");
Kokkos::Tools::popRegion();
```

As always: easy to integrate!

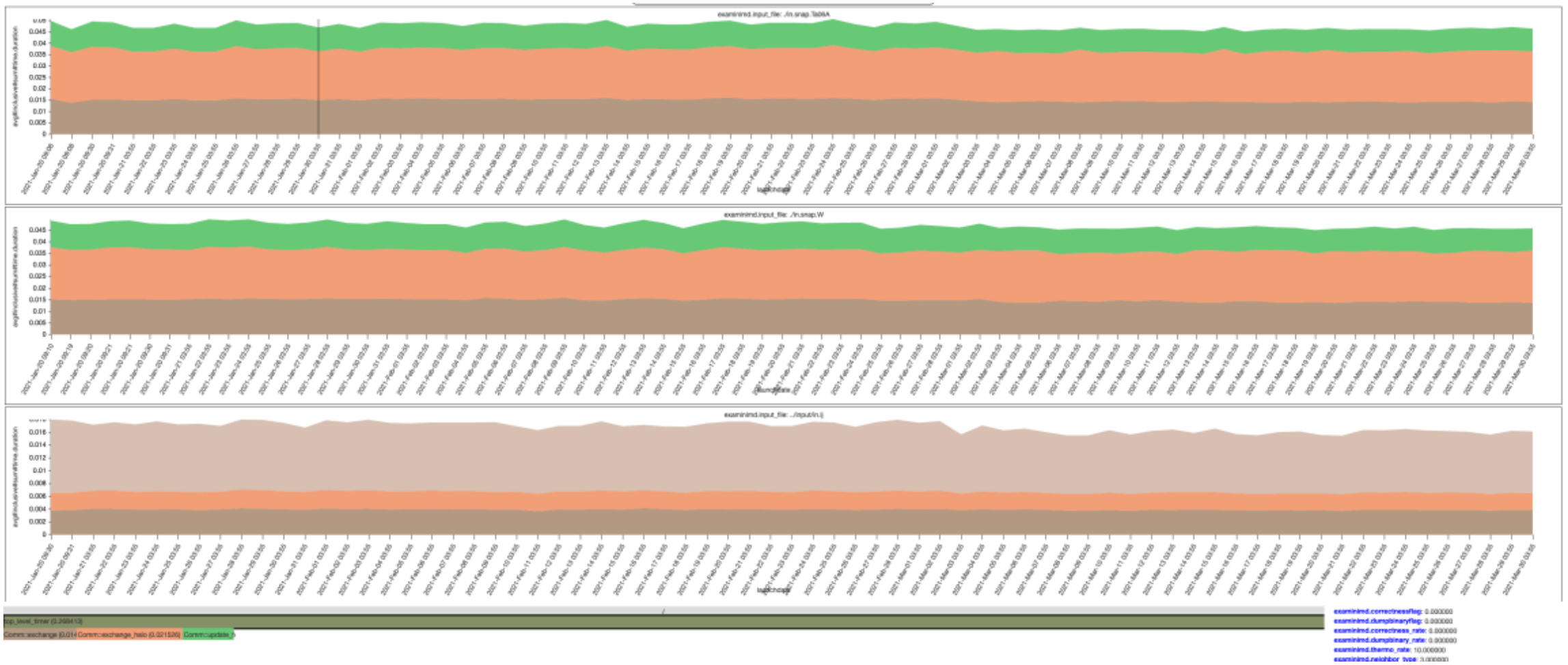
RAJA Perfsuite testing

- Adapted Rich Hornung's RAJA Perfsuite to test whether Kokkos has introduced new complexity to make optimization impossible



Graphs don't slope up: we get to keep our jobs!

ExaminiMD



We didn’t ruin our customers’ days either!

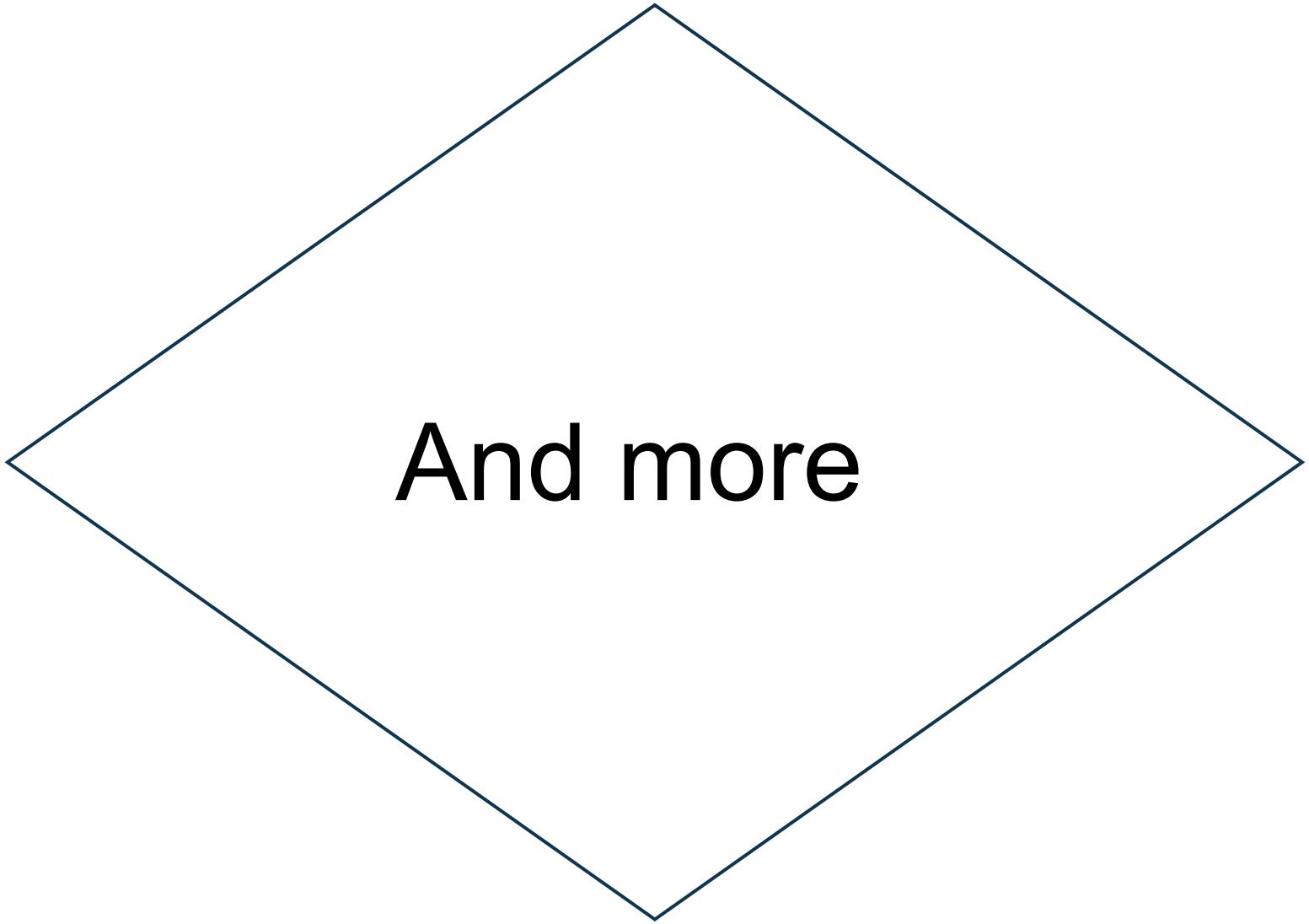
Spot info

- Option one: time machine, take the tutorial they gave Monday
- Option two: email David Boehme (boehme3@llnl.gov) and ask for the recording

- Working on hosting the web infrastructure at ORNL and NERSC

- Also in progress: Watchr integration (Jenkins plugin based performance tracking), LDMS streams

Moving to production


And more

The laundry list

- Improvements to allow tools without adding Kokkos fences
- Tools to track UVM data movement
- Updates in Kokkos Clang-Tidy
- Additional autotuning tools (Labrador and CConfigSpace and Apex)
- DualView callbacks to track DualView actions
- Power monitoring with Variorum
- Improved TAU support
- Timemory support
- Godbolt/Compiler Explorer instances
- **kokkosteam.slack.com**
- **dzpolia@sandia.gov**