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# KEEPING TRILINOS RUNNING PERFORMANTLY EVERYWHERE EVERY NIGHT

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# MOTIVATION

- Motivation: Taking ownership of Trilinos performance
  - Avoid (negative) surprises by the app teams saving them time.
  - Reducing time for initial setup for apps / developers on new-to-them systems / updated libs.
  - Work with Sandia Application Performance Team (APT) to stay at the most recent "good" version of libraries.
  - Understand behavior across time and across different systems.
  - Provide a way for app teams to know if it is safe to update Trilinos.
- FY25 Team: Chris Siefert, Jonathan Hu, Luc Berger-Vergiat, Tim Fuller, Curt Ober.

# WHAT DO WE MEAN BY “RUNS EVERYWHERE” ?

## CPU

Eclipse (Broadwell)  
Amber (Sapphire Rapids/DDR)  
Tachi/Rocinante (Sapphire  
Rapids/HBM)

## NVIDIA GPU

Vortex (V100)  
Perlmutter (A100)  
Hops (H100)

## AMD GPU

Frontier (MI250)  
Tioga (MI250)  
RZAdams/El Dorado (MI300)

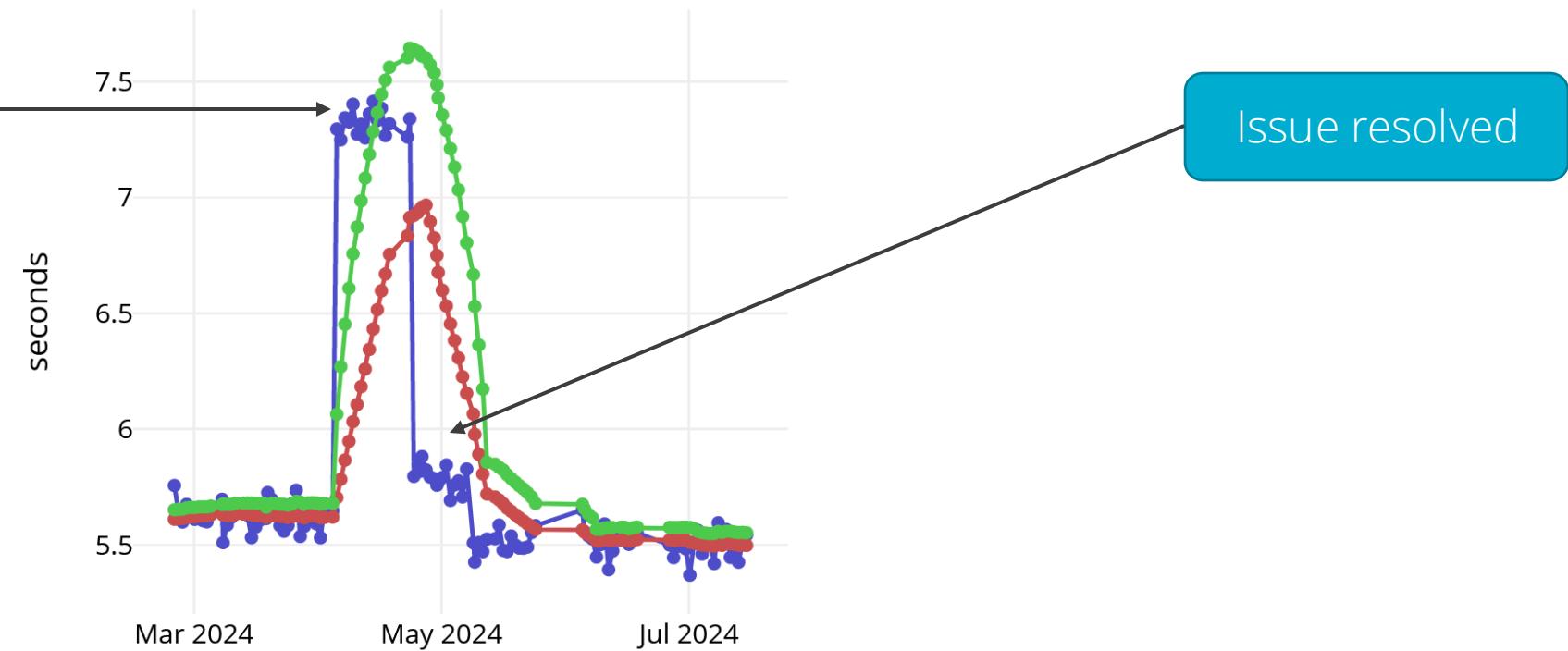
## Intel GPU

Aurora (Intel Max)

# WATCHR<sup>[1]</sup> PERFORMANCE SYSTEM

- Consists of 36 tests<sup>[2]</sup> run nightly on relevant systems covering Tpetra, Epetra, Intrepid2, MueLu, FROSCh and proxies for EMPIRE, SPARC, SIERRA-SD and SIERRA-TF.

/Amber Serial: Tpetra FE Assembly 9 ranks



[1] <https://github.com/sandialabs/watchr-core> (developed by E. Ridgway)

[2] Not every test is run on each system --- Some are CPU or GPU only, others require certain TPLs, etc.

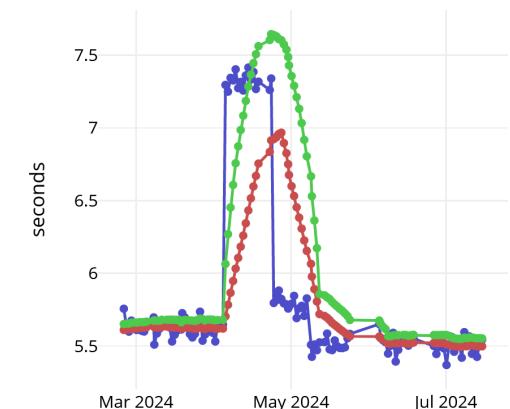
## SUCCESS STORY #1: KOKKOS 4.3

- Kokkos 4.3 update switched the default behavior of operations in Kokkos::Serial.
  - They became atomic by default.
  - This makes Kokkos behavior correct if you use Kokkos::Serial within a threaded calculation.
  - Trilinos doesn't do that, so performance degraded.
- After consultation with the Kokkos Team, we...
  - Changed the performance builds to use the `-DKokkos_ENABLE_BYPASS_ATOMICS=ON`
  - Emailed stakeholders recommending they do likewise.
  - Personal correspondence with stakeholders who had more questions.

/Amber Serial: Tpetra FE Assembly 9 ranks

Issue detected and resolved before apps even noticed.

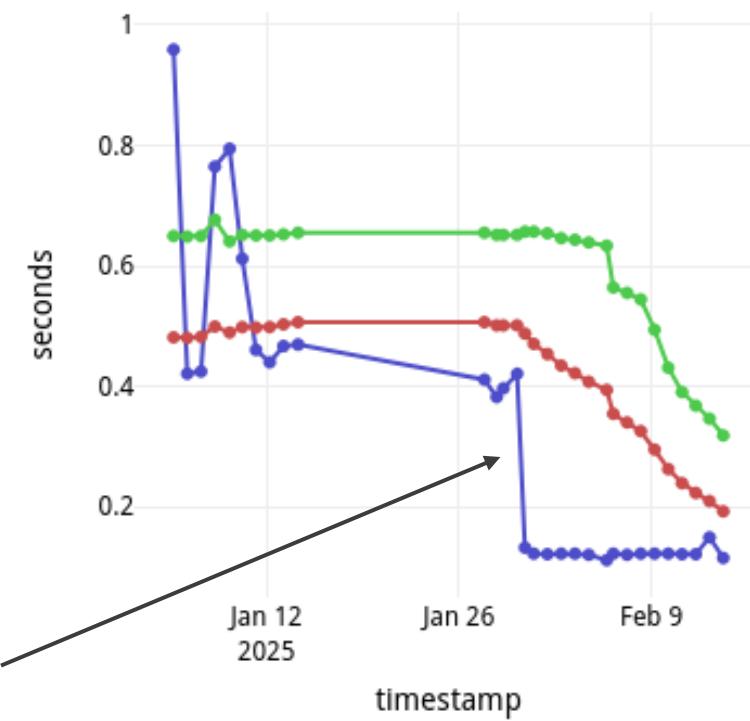
Credit to Christian Trott for helping us diagnose the issue!



## SUCCESS STORY #2: FRONTIER MODULE UPDATE

- Early Trilinos testing used ROCM 5.7.1.
- OLCF made ROCM 6.1.3 available in Q1.
- What would the effect on Trilinos be?
- Result: Automatically captured 2x performance increase on certain tests!

/FRONTIER: Tpetra CGSolve 4 ranks





# HPC CONFIGURATIONS REPO

- Single one-stop location for SNL users to get the nightly build script.
- Goal: Push configurations for NERSC / OLCF / ALCF to [github.com](https://github.com) for non-SNL Trilinos users.

 **Trilinos-HPC-configurations** 

77 Commits 1 Branch 0 Tags 44 KiB Project Storage

Automatic update of stoplight chart. User edits will be clobbered.  
Chris Siefert authored 7 hours ago e8fffc1e0

master / trilinos-hpc-configurations / +

History Find file Edit Code

README Add LICENSE Add CHANGELOG Add CONTRIBUTING + Set up CI/CD Configure Integrations

Name	Last commit	Last update
amber	Automatic nightly update. User edits will be clobbered.	2 weeks ago
crusher	Automatic nightly update	2 months ago
eclipse	Automatic nightly update. User edits will be clobbered.	2 weeks ago
frontier	Automatic nightly update. User edits will be clobbered.	4 weeks ago
hops	Automatic nightly update. User edits will be clobbered.	3 weeks ago
lassen	lassen build	4 months ago
perlmutter	Automatic nightly update. User edits will be clobbered.	1 month ago
rocinante	Automatic nightly update. User edits will be clobbered.	1 month ago
rzvernal	Automatic nightly update. User edits will be clobbered.	1 week ago
stria	Automatic nightly update. User edits will be clobbered.	2 weeks ago
tachi	Automatic nightly update. User edits will be clobbered.	4 weeks ago
tioga	Automatic nightly update. User edits will be clobbered.	1 week ago
vortex	Automatic nightly update. User edits will be clobbered.	3 weeks ago

Credit to Christian Glusa for the idea!

# DAILY STOPLIGHT CHART

- Did the tests run at all?
  - DST, Cron/Jenkins fails
- Did individual tests stop running?
  - Code crashes
- Has the performance degraded?
  - Still works, but worse.

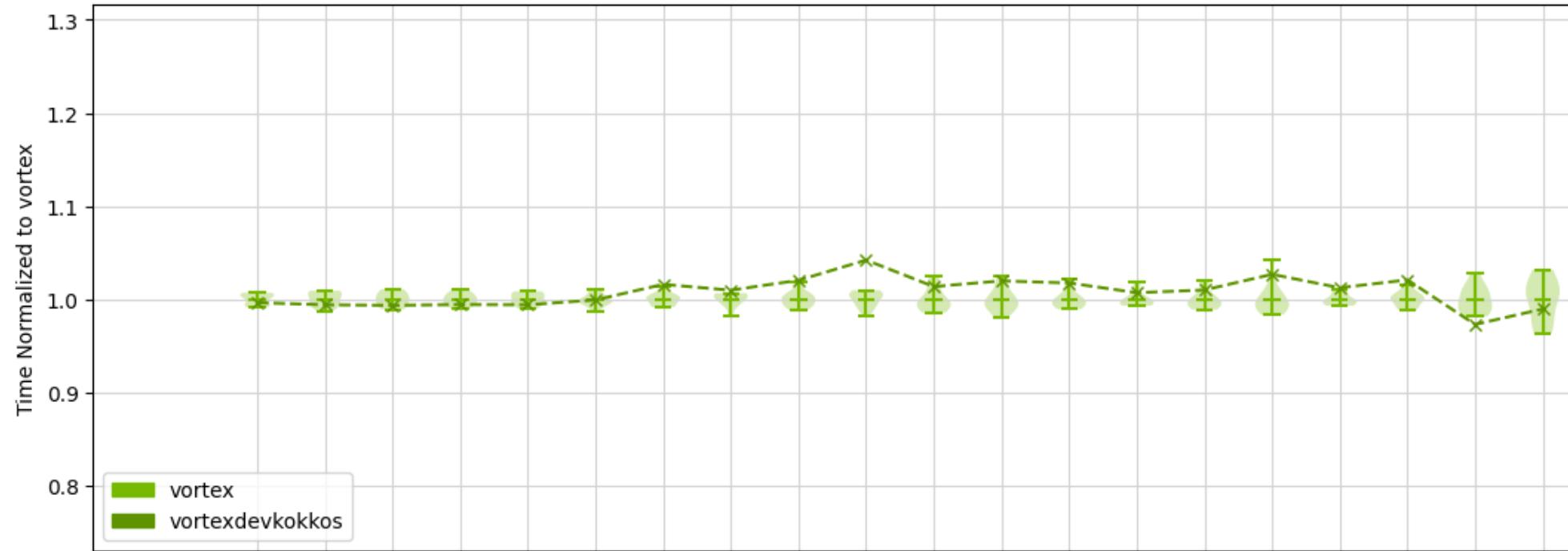
Current builds managed by the Tpetra/Performance team

System	Days Run	Epetra	FROSch	Intrepid2	MiniEM	MueLu	SIERRA/SD	SIERRA/TF	SPARC	Tpetra
Amber	7/7	2.0 / 2 1.0	4.0 / 4 1.0	1.0 / 1 1.0	3.0 / 3 1.0	4.0 / 4 1.0	1.0 / 1 ---	7.9 / 8 1.0	---	13.0 / 13 1.0
Eclipse	7/7	2.0 / 2 1.0	4.0 / 4 1.0	1.0 / 1 1.0	3.0 / 3 1.0	4.0 / 4 1.0	1.0 / 1 ---	8.0 / 8 1.0	---	11.0 / 11 1.0
Rocinante	7/7	---	---	---	3.0 / 3 1.0	4.0 / 4 1.0	1.0 / 1 ---	---	---	13.0 / 13 1.0
Stria	7/7	2.0 / 2 1.0	---	1.0 / 1 1.0	3.0 / 3 1.0	4.0 / 4 1.0	1.0 / 1 ---	8.0 / 8 1.0	---	11.0 / 11 0.9
Vortex	4/7	---	---	---	3.0 / 3 1.0	4.0 / 4 1.0	1.0 / 1 ---	8.0 / 8 1.0	4.0 / 4 1.0	13.0 / 13 0.8
Frontier	7/7	---	---	---	1.0 / 1 1.0	4.0 / 4 1.0	1.0 / 1 ---	---	4.0 / 4 1.0	5.0 / 5 1.0
Perlmutter	7/7	---	---	---	---	3.0 / 3 1.0	1.0 / 1 ---	---	---	2.0 / 2 1.0
Hops	7/7	---	---	---	---	4.0 / 4 1.0	1.0 / 1 ---	---	---	5.0 / 5 1.0
RZVernal	7/7	---	---	---	---	1.9 / 2 1.0	1.0 / 1 ---	---	4.0 / 4 1.0	3.0 / 3 1.0
Tioga	7/7	---	---	---	1.0 / 1 1.0	4.0 / 4 1.0	1.0 / 1 ---	---	4.0 / 4 1.0	3.0 / 3 1.0

Credit to Michael Wolf for the idea!

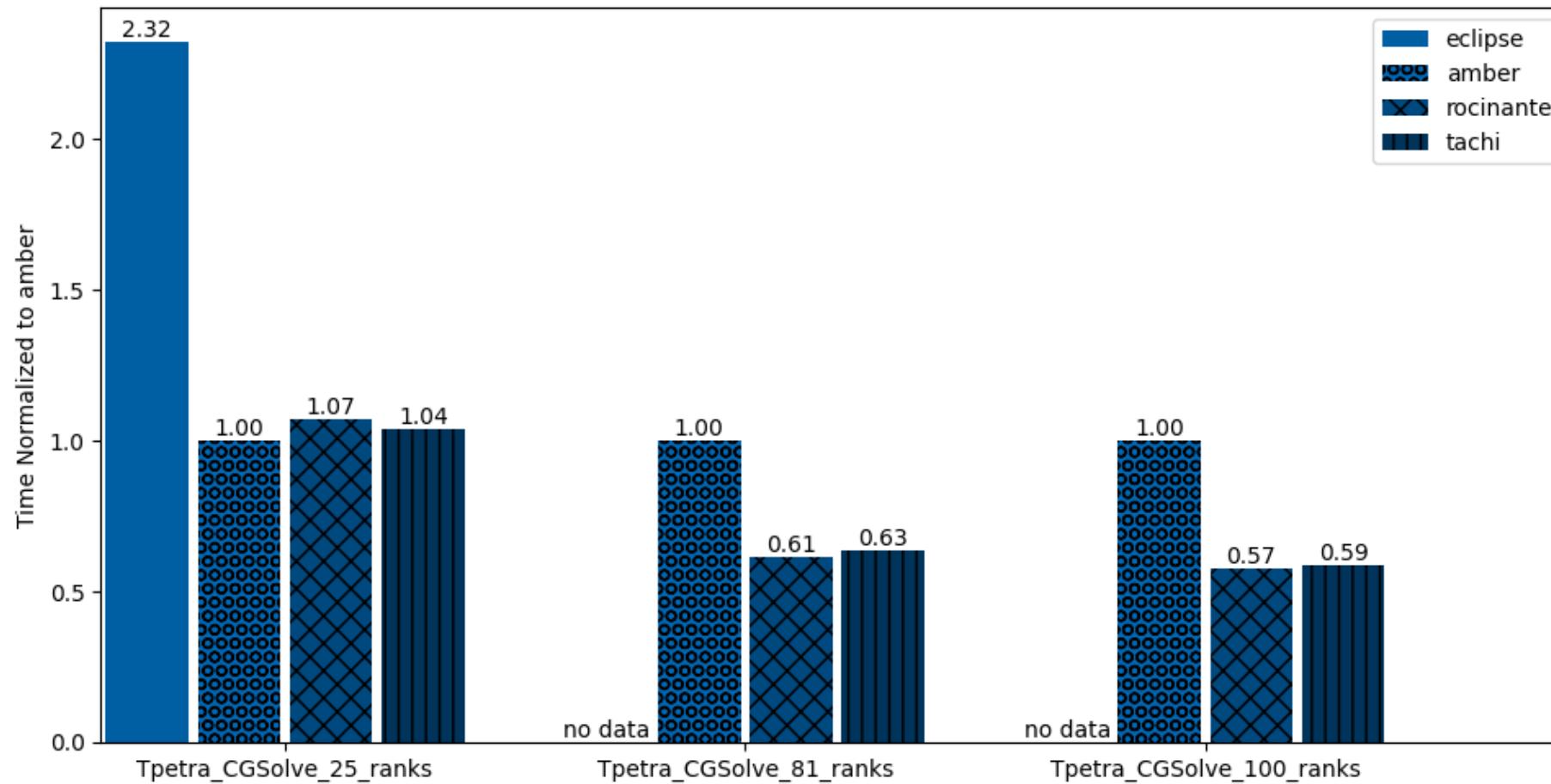
Last updated: 2024\_07\_09

# KOKKOS / KOKKOS KERNELS DEVELOP INTEGRATION



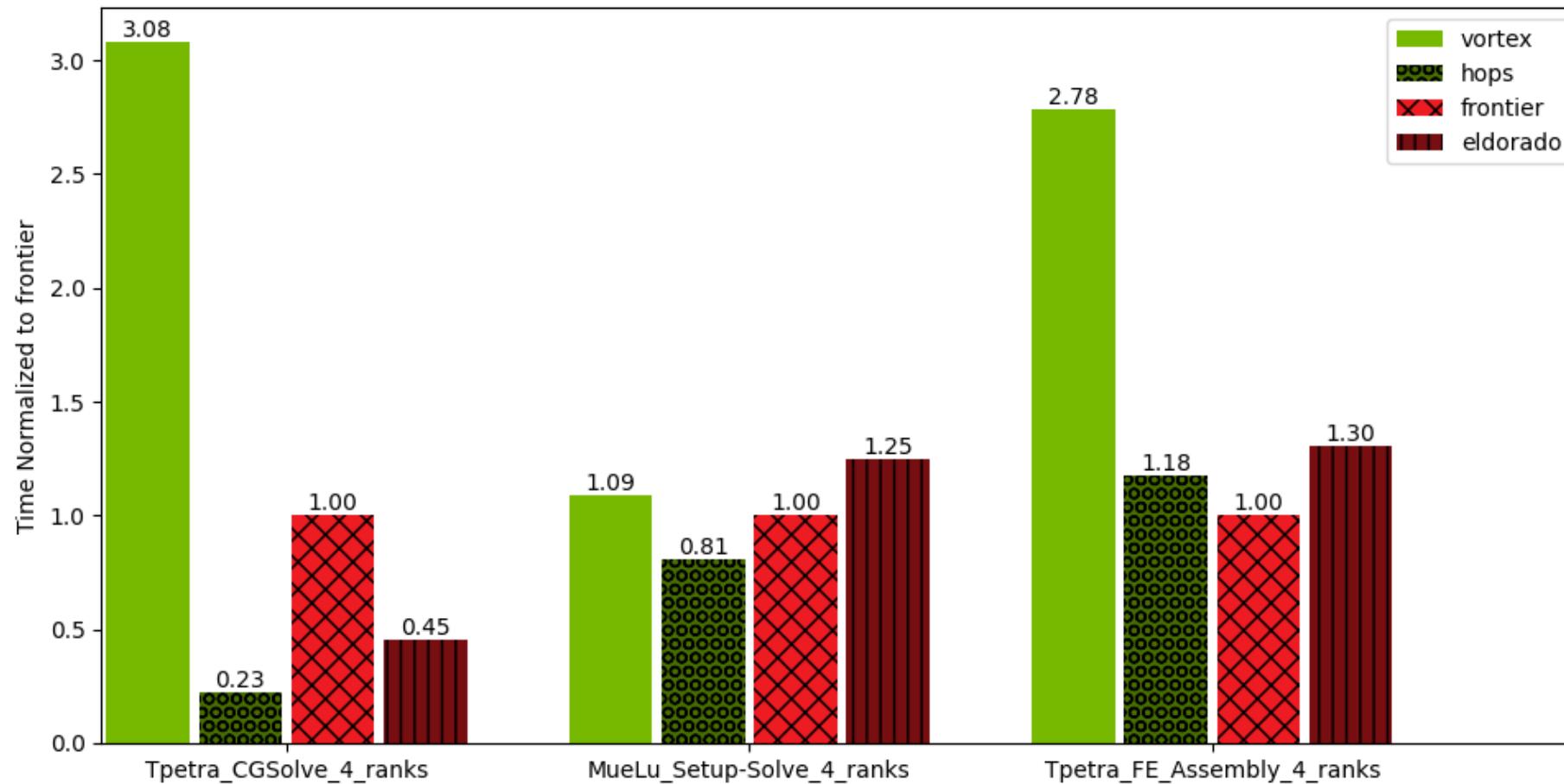
- Does using develop Kokkos have a performance impact on Trilinos performance?

## CROSS-SYSTEM COMPARISONS: CPU



- Note how HBM (Roci/Tachi) only offer speedup over DDR (Amber) for higher core counts.

## CROSS-SYSTEM COMPARISONS: GPU



- Early access to El Dorado has exposed performance issues.

## FILESYSTEM ISSUES CAN MUDDLE PERFORMANCE RESULTS

- Up 4x slowdown on El Dorado vs. expected performance!
- Worked with James Elliott (SNL/APT) to identify issue.
  - Short running tests w/ big binaries show this... on the first run.
  - We believe this due to the OS getting the file off "disk" and into memory.
  - Have a non-Trilinos reproducer.
  - This issue is *not* unique to El Dorado.
- Portable mitigation: `ctest --repeat until-fail:2`
  - This will run the test twice and record the second run's timings.
  - Other options include using machine-specific RAM disks or local storage.
- With the mitigation, El Dorado results look a lot better.

## REMARKS & FUTURE DIRECTIONS

- We've provided a *maintained* means for dissemination of "good" Trilinos configurations.
- Trilinos Tpetra/Performance team reviews the results once a week.
  - Weekly feedback provided to Kokkos / KokkosKernels teams as well
- Cross-system comparisons provide feedback to apps and admins.
- Looking forward
  - Getting the user facility configurations on the open internet.
  - Working with admins to identify & flag system issues (e.g. thermal throttling, file system issues) automatically.
  - Proxies for more Trilinos applications.
  - Adding DOE-relevant systems as they come online.



<https://github.com/trilinos/Trilinos>