KOKKOS KERNELS: STATE ON EXASCALE ARCHITECTURES

Sandia
National
Laboratories

Exceptional service in the national interest

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U.S. DEPARTMENT OF ENERGY

NNSA
National Nuclear Security Administration

KOKKOS KERNELS AND EXASCALE

- Portable math kernels for Kokkos
  - "native" implementations
  - compatibility wrappers for "TPLs", a.k.a third-party libraries (e.g cuSparse, MAGMA)
- No distributed-memory implementations

Exascale System*	Processor	KOKKOS_ARCH_
Frontier	AMD MI250X GPU	...AMD_GFX90A
El Capitan	AMD MI300A APU	...AMD_GFX942
Aurora	Intel Data Center Max GPU	...INTEL_PVC
Aurora	Intel Sapphire Rapids CPU	...SPR
N/A	Nvidia H100 GPU	...HOPPER90
N/A	Nvidia A100 GPU	...AMPERE80

current or anticipated

MI250X (AND MI300A)

- MI300A not available yet
  - AMD contributing early ROCm 6.0 adjustments

- TPLs
  - Broad coverage from rocSPARSE, rocBLAS,
  - Support from rocSOLVER in progress

- Known Issues
  - None (ROCm 5.6.0)

- PR tests on MI210

INTEL PONTE VECCHIO

- Recent access to Aurora: Intel Data Center Max GPU 1550

- TPLs
  - spotty oneMKL coverage, more in progress

- Known Issues
  - native SpGEMM
  - native COO -> CRS matrix conversion
  - oneMKL gemv NaN handling (reported to Intel, may already be fixed on Aurora)
  - investigating potential SpMV performance regression in oneMKL 2024 vs 2023

- Nightly SYCL tests in place on Data Center GPU Max 1100
  - working on promoting to PR tests
 - Much smaller: 1/2 cores, 1/3 HBM

INTEL SAPPHIRE RAPIDS

- TPLs
  - Broad coverage of BLAS and sparse from oneMKL

- Known Issues
  - Mishandling of integer size types on some oneMKL configurations

- Nightly tests with KOKKOS_ARCH_SPR

NVIDIA H100, A100

- TPLs
  - Broad coverage from cuBLAS, cuSPARSE, and cuSOLVER

- Known Issues
  - None (CUDA 11.8)
  - Batched dense (H100, CUDA 12)

- Nightly tests on H100
  - Working on transitioning V100 PR tests to A100 or H100

SPMV AND GEMM PERFORMANCE RESULTS

KokkosSparse::spmv

KokkosBlas::gemm
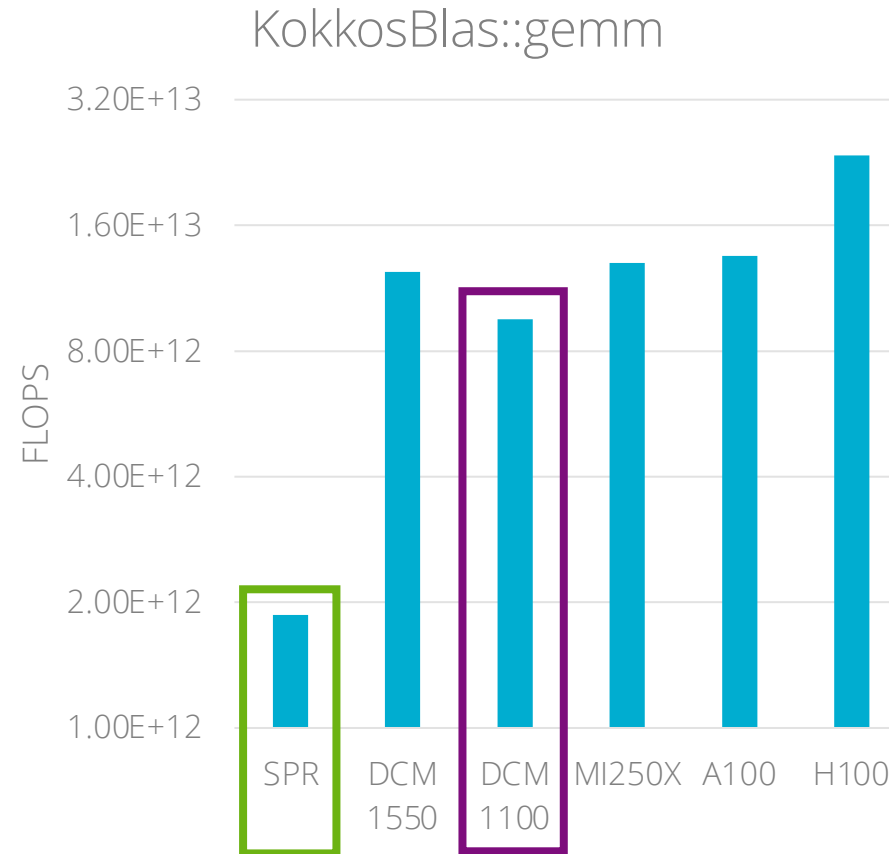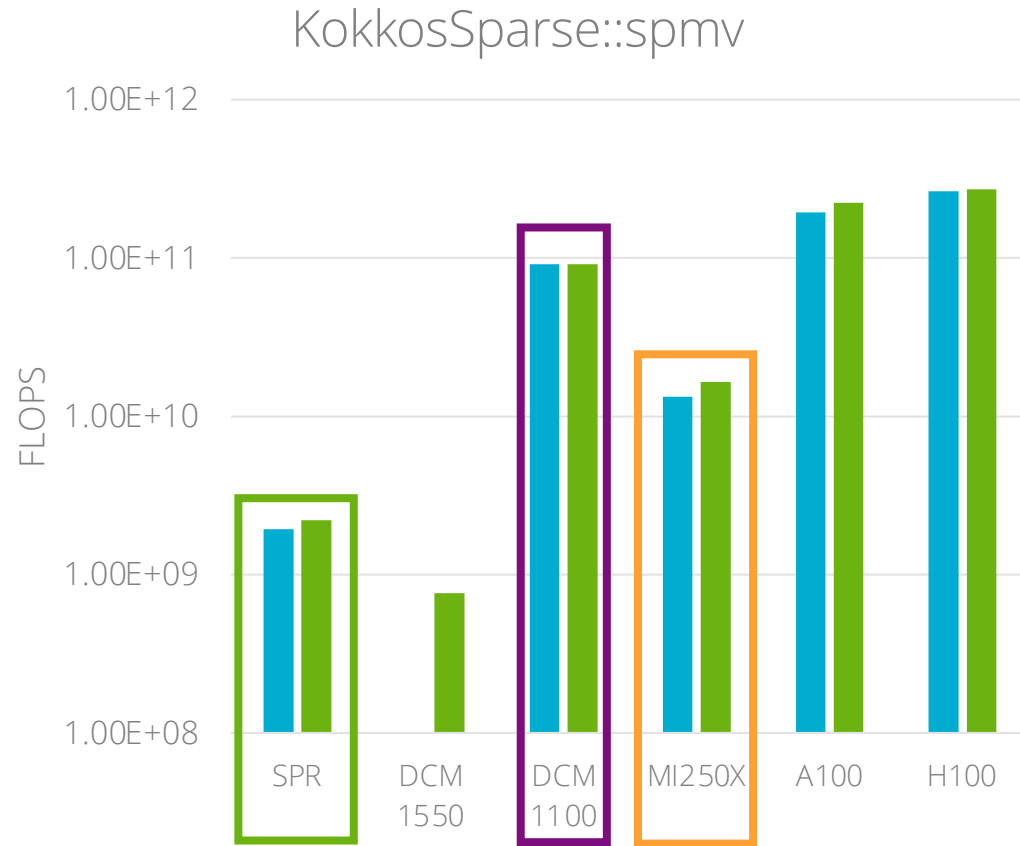
no stacked HBM

smaller GPU than Aurora

AMD is working on this

next slide

- ■ fp64, N=1.8M, nnz=88M
- ■ fp64, N=1.1M, nnz=89M

fp64, m=n=k=1000

POSSIBLE SPMV REGRESSION IN MKL2024
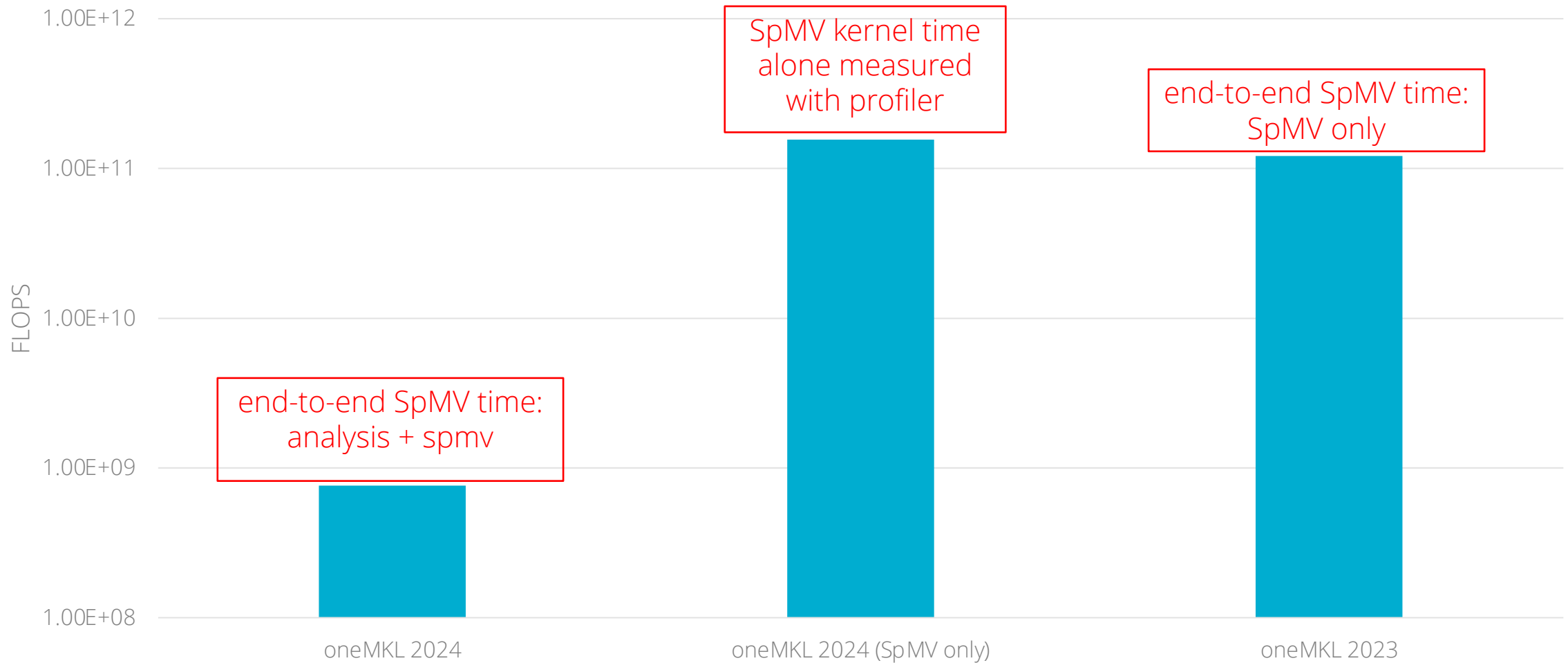
NOTES ON THE PREVIOUS RESULTS

- SPR: Sandia: oneAPI 2023.1.0

- MI250X: Frontier @ OLCF, ROCm 5.3.0

- DCM 1100: Sandia, oneAPI 2023.1.0

- DCM 1550: Aurora @ ALCF, oneAPI 2024
  - preliminary investigation suggests oneMKL 2024 SpMV now includes an analysis pass, which causes a performance regression for the tested configuration compared to oneMKL 2023.

- A100: Perlmutter @ NERSC: CUDA 11.7

- H100: Sandia: CUDA 11.8

ACKS