Belle-II Benchmark

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Belle II at SuperKEKB

Plan to collect 50 ab⁻¹ of collisions at and near $\Upsilon(4S)$
Successor to Belle at KEKB (1.05 ab⁻¹)

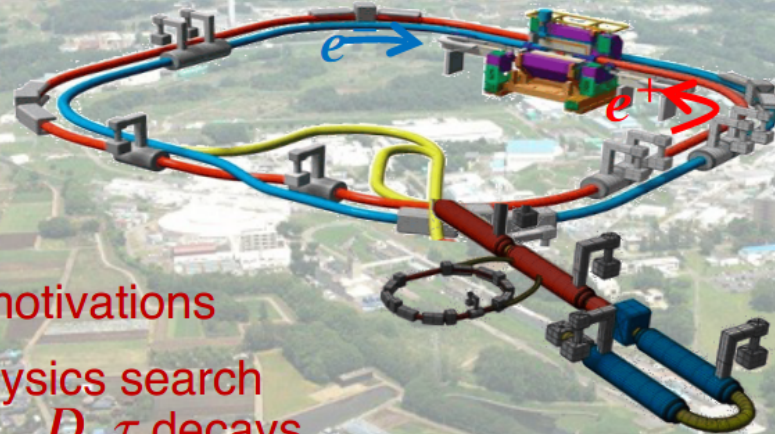At $\Upsilon(4S)$, E_{CM} = 10.58 GeV
7 GeV e^- (HER; High Energy Ring)
4 GeV e^+ (LER; Low Energy Ring)

Belle II detector

Nano beam scheme

$$\mathscr{L} = \frac{\gamma_\pm}{2er_e}\left(1 + \frac{\sigma_y^*}{\sigma_x^*}\right)\frac{I_\pm \xi_{\pm y}}{\beta_y^*}\left(\frac{R_L}{R_y}\right)$$

5.9 → 0.3 mm
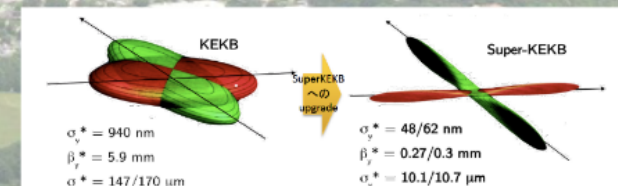KEKB   SuperKEKB

Physics motivations

- New physics search in B, B_s, D, τ decays
- Direct search for light new particles
- Precise measurement of Standard Model
- Hadron physics

Slide from "Belle II at SuperKEKB" by Toru Iijima, BEAUTY2020

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Benchmark Under Development

- Simulation of B0/anti-B0 events, currently background-free

- Includes detector and trigger simulation, track reconstruction

- Containerized using scripts in https://gitlab.cern.ch/hep-benchmarks/hep-workloads

- Belle-2 specific part available at https://github.com/TristanSullivan/Belle2Benchmark

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Compatibility with HEPscore

- Docker container that accepts number of events, copies, and threads as command-line arguments

- Saturates cores of machine by default (have both single-threaded and 4-threaded versions)

- Outputs JSON, including throughput score in total events processed per second
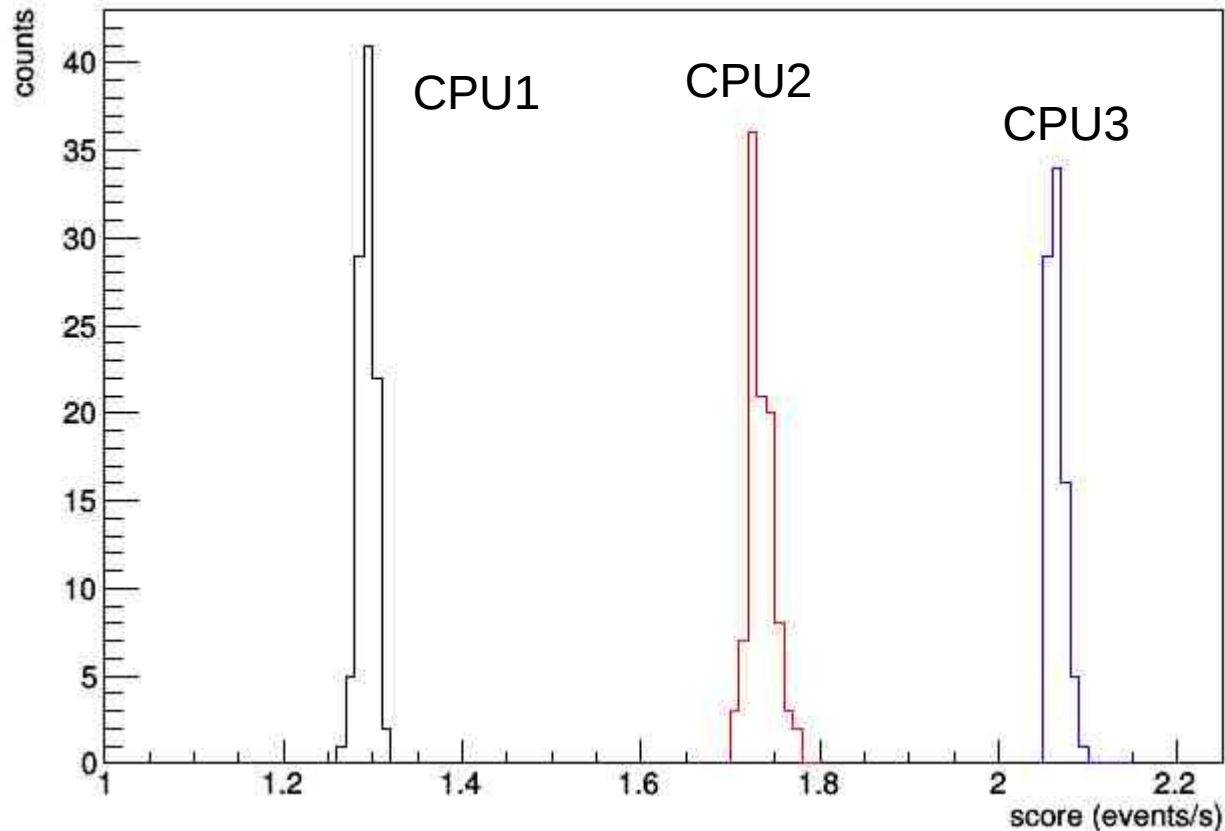
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Results

The benchmark was run on a small Openstack cloud at UVic, used for testing

8 core VMs, 2 GB RAM / core
No other VMs on the hypervisors (dedicated machines)

Belle-2 Benchmark

CPU1 = Intel Xeon CPU E5-2670, 2.6 Ghz, family 6, model 45, stepping 7
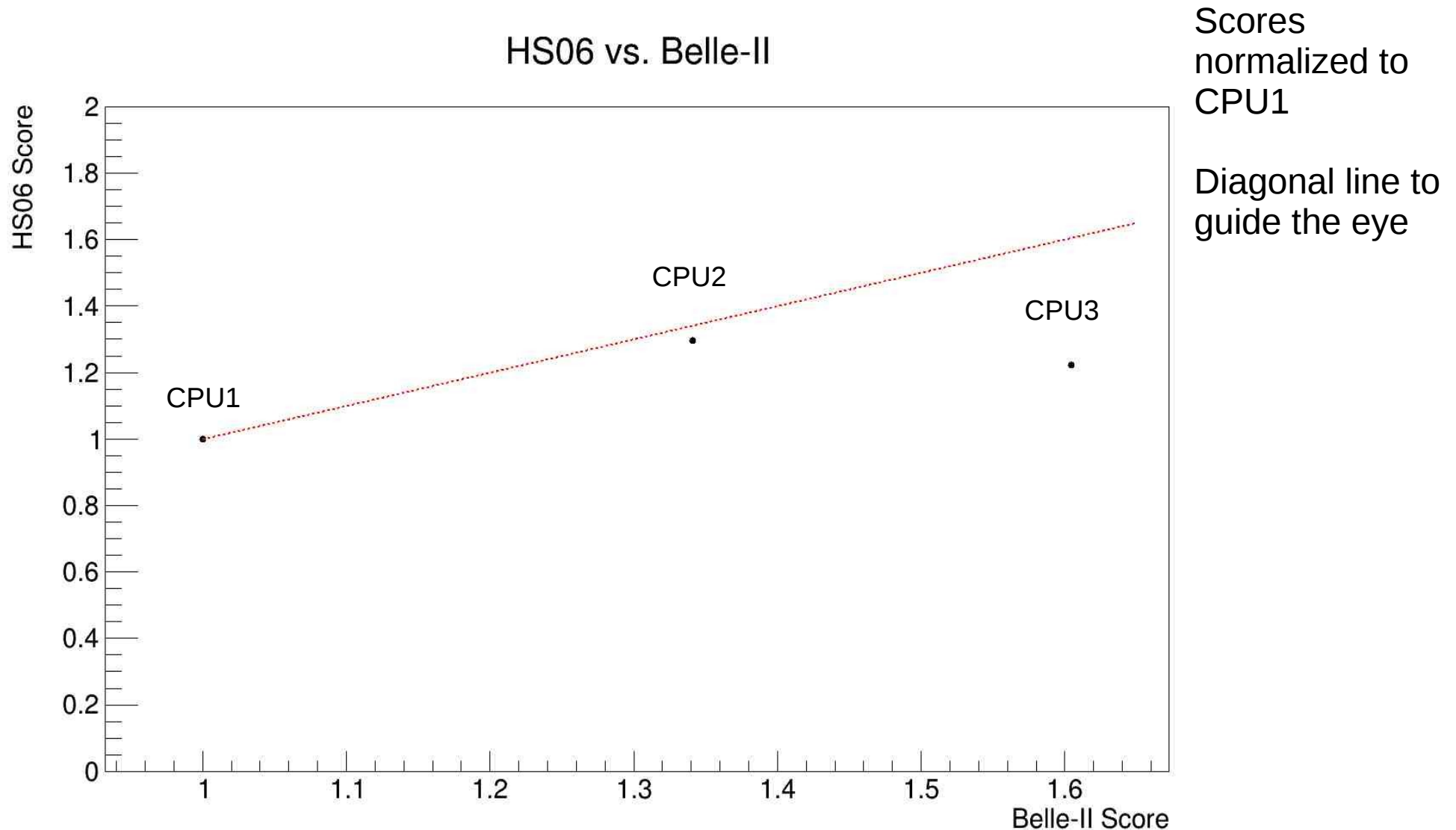
CPU2 = Intel Xeon Gold 6226 CPU, 2.7 GHz, family 6, model 85, stepping 7

CPU3 = Intel Xeon CPU E5-2687W, 3.0 GHz, family 6, model 79, stepping 1
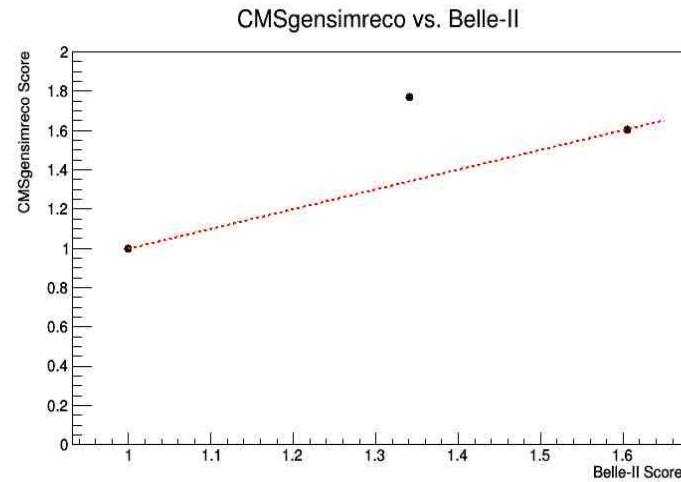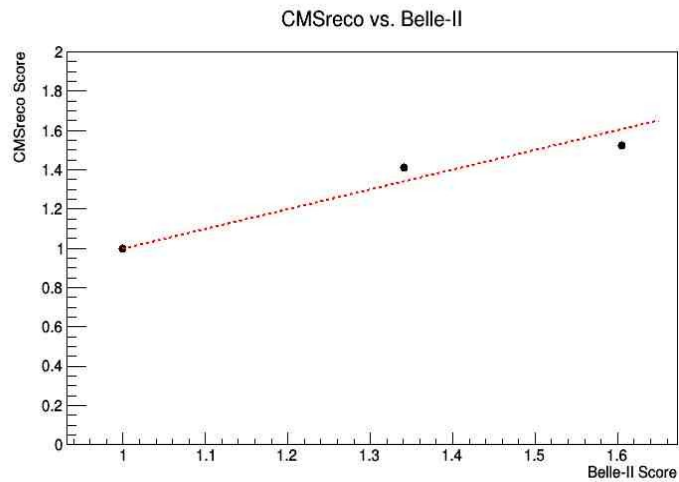
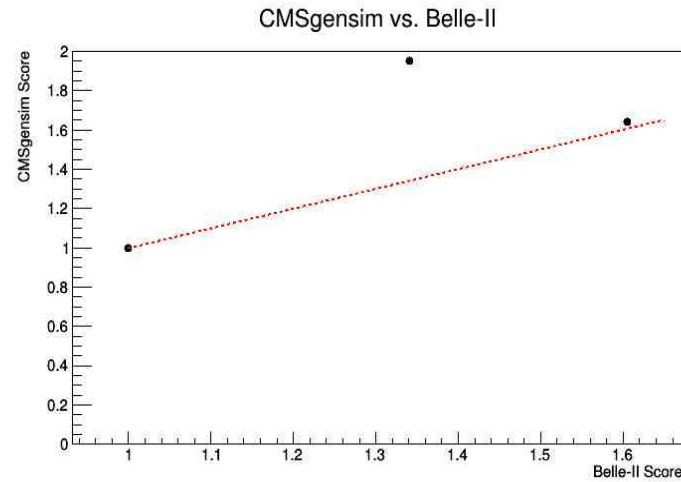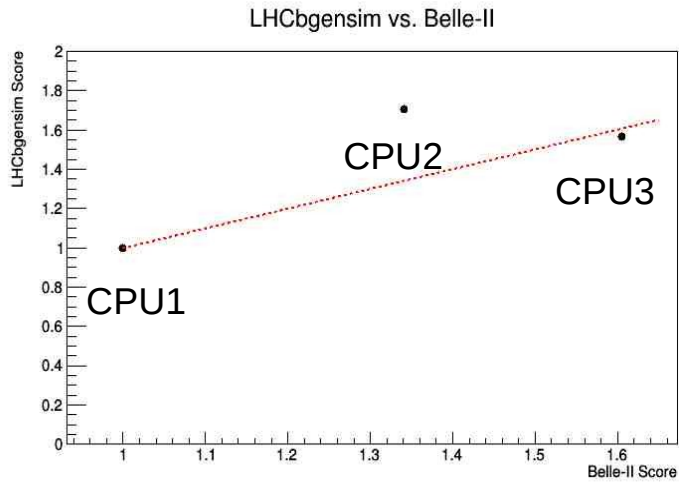CPU2 is the newest

CPU3 has highest clock frequency

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Benchmark Comparison

Scores
normalized to
CPU1

Diagonal line to
guide the eye

HS06 vs. Belle-II

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Benchmark Comparison

Scores normalized to CPU1

Diagonal lines to guide the eye

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Summary

- All results preliminary; exact choice of benchmark pending formal approval by Belle-2 collaboration (event type, whether to include background and reconstruction)

- Workload seems to behave reasonably so far; running on more CPU types would clarify scaling relative to the other workloads

- Ready to test integration into HEPscore?

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Supplementary Material

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Detailed Machine Information

- CPU1 HV:
  - 32 cores with HT on
  - Two numa nodes
  - 10 x 8192 MB RAM, DDR3, 1600 MT/s
  - L1d cache: 32 K
  - L1i cache: 32K
  - L2 cache: 256 K
  - L3 cache: 20480 K

- CPU2 HV:
  - 48 cores with HT on
  - Two numa nodes
  - 6 x 16384 MB RAM, DDR4, 2933 MT/s
  - L1d cache: 32 K
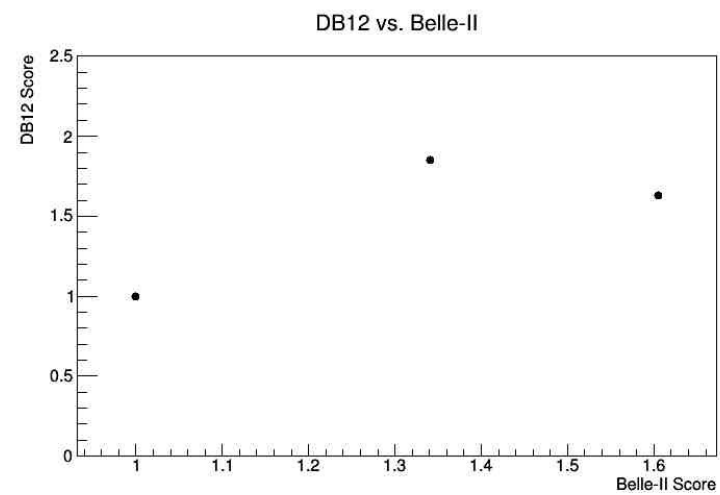 - L1i cache: 32K
  - L2 cache: 1024 K
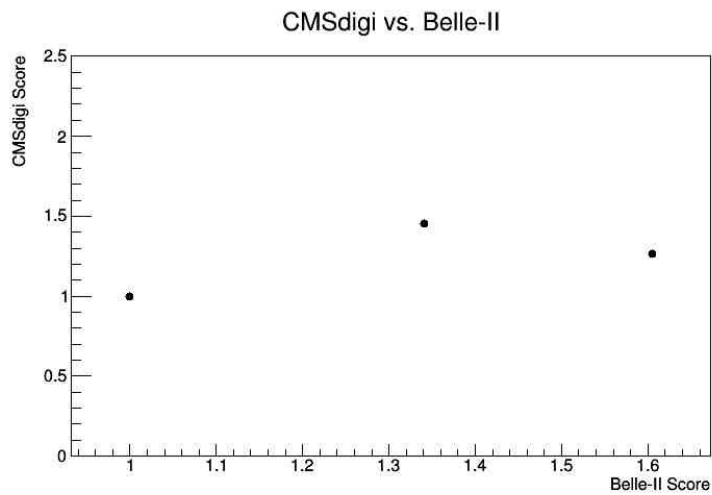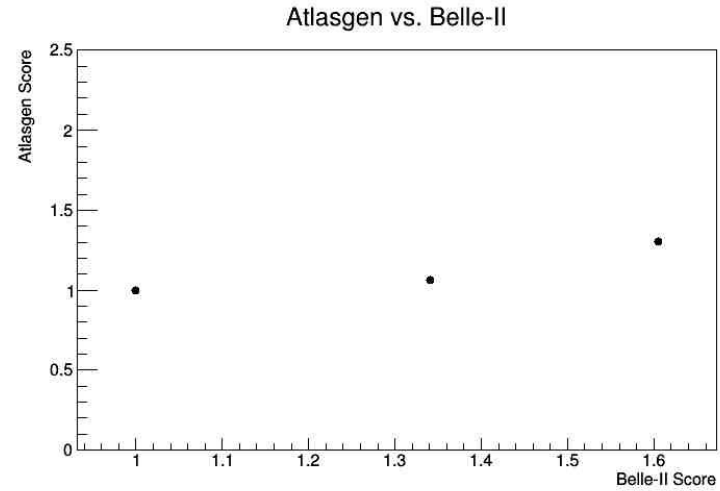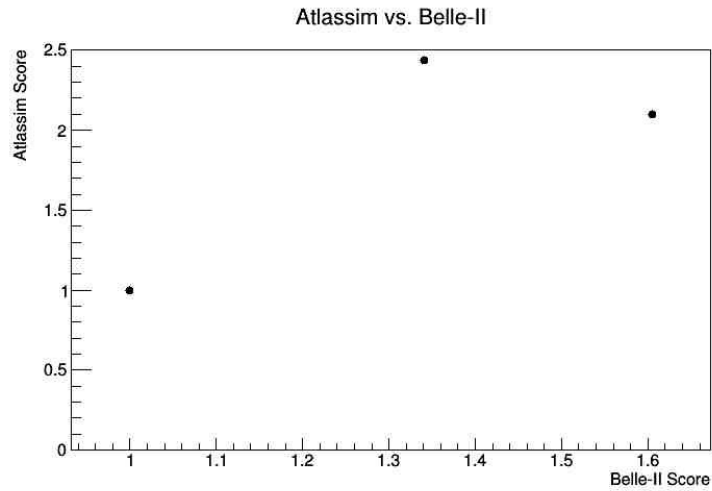 - L3 cache: 19712 K

- CPU3 HV:
  - 48 cores with HT on
  - Two numa nodes
  - 6 x 16384, 2 x 8192 MB RAM, DDR4, 2400 MT/s
  - L1d cache: 32 K
  - L1i cache: 32K
  - L2 cache: 256 K
  - L3 cache: 30720 K

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Detailed Benchmark Information

- Atlas-gen: 200 events, 1 thread, 10 minutes
- Atlas-sim: 10 events, 4 threads, ~90 minutes
- LHCb-gen-sim: 5 events, 1 thread, ~25 minutes
- CMS-reco: 50 events, 4 threads, ~10 minutes
- CMS-digi: 50 events, 4 threads, ~5 minutes
- CMS-gen-sim: 20 events, 4 threads, ~15 minutes
- Belle2-gen-sim-reco: 20 events, 1 thread, ~5 minutes
- Times are for CPU1
- Threads * copies = cores of machine (all cores used by default)
- Benchmark score is total events processed per second (sum of individual scores)
- Spreadsheet with scores: https://docs.google.com/spreadsheets/d/1TN6xaVarEcQ6LBart505fHQ3HnRrcWerKofi5bKsA08/edit#gid=0

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Benchmark Comparison

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Runs Without Dedicated HVs

Atlas Sim vs. Atlas Gen

Black = CPU1
Red = CPU2
Blue = CPU3

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