Belle-II Benchmark

Tristan Sullivan,
Randall Sobie, Marcus Ebert

University of Victoria
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tssulliv@uvic.ca

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)

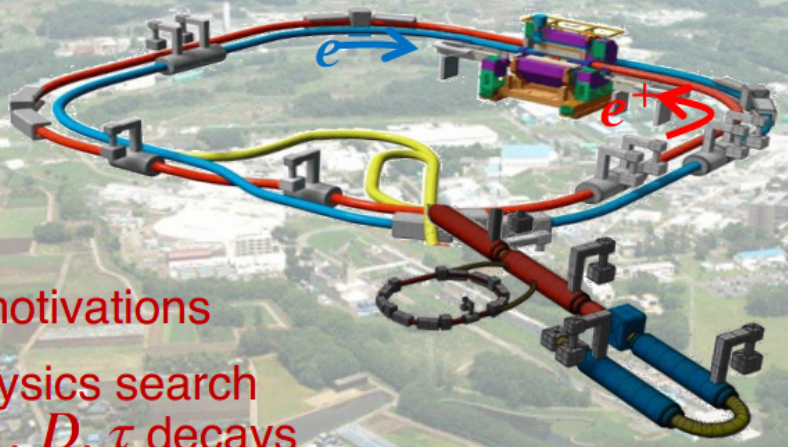
Nano beam scheme

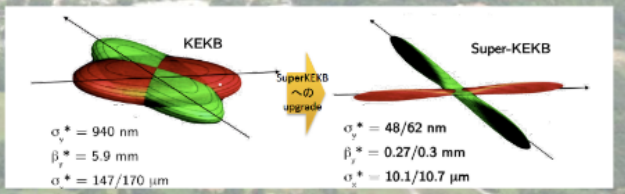
$$\mathscr{L} = \frac{\gamma_\pm}{2er_e}\left(1+\frac{\sigma_y^*}{\sigma_x^*}\right)\frac{I_\pm \xi_{\pm y}}{\beta_y^*}\left(\frac{R_L}{R_y}\right)$$

5.9 → 0.3 mm

KEKB SuperKEKB

Belle II detector





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

Proposed Benchmark

- Simulation of B0/anti-B0 events, currently background-free
- Includes detector and trigger simulation, reconstruction optional
- Containerized using scripts in https://gitlab.cern.ch/hep-benchmarks/hep-workloads
- Belle-2 specific part available at https://github.com/TristanSullivan/Belle2Benchmark

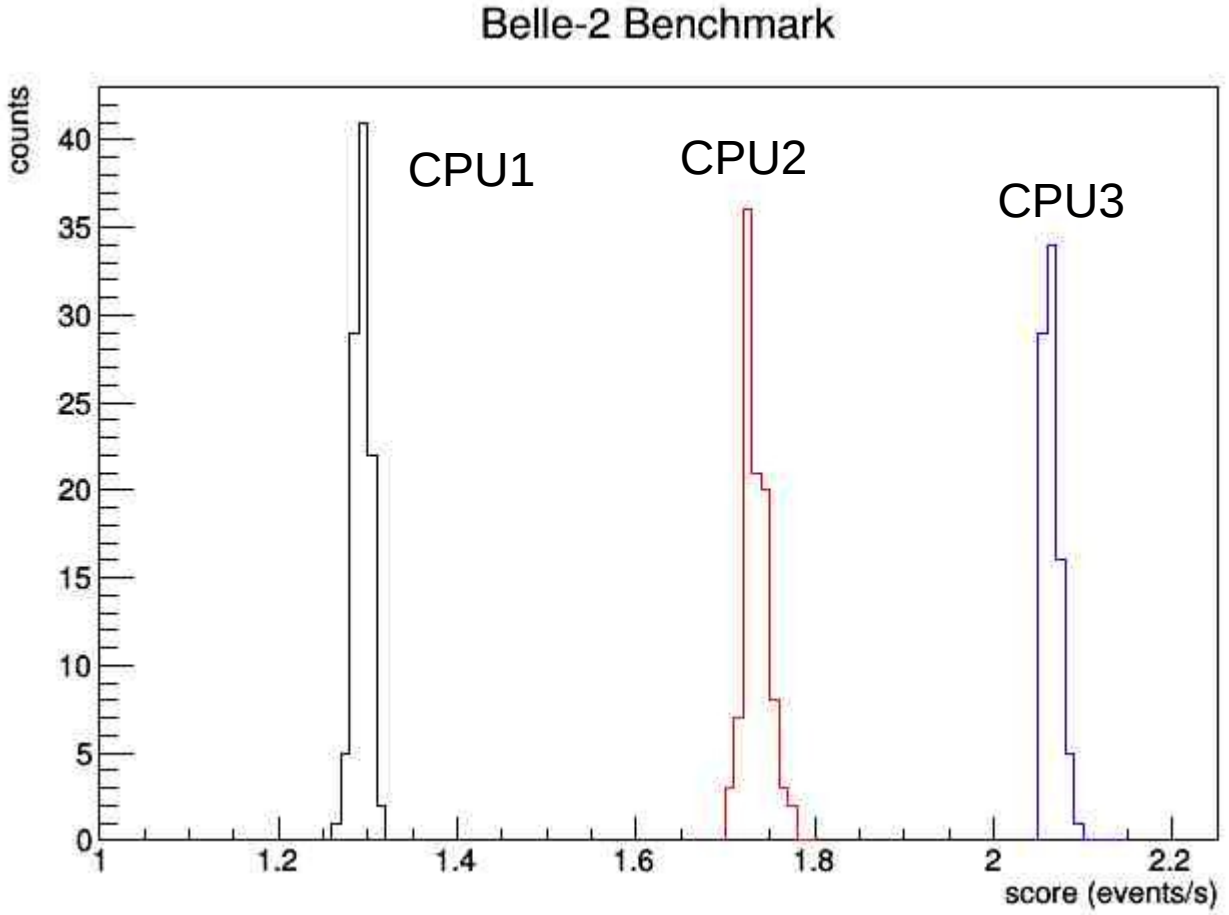
Compatibility with HEPscore

- 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

Results

The benchmark (single-threaded, including reconstruction) 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)



CPU1 = Intel Xeon CPU E5-2670, 2.6 Ghz, family 6, model 45, stepping 7

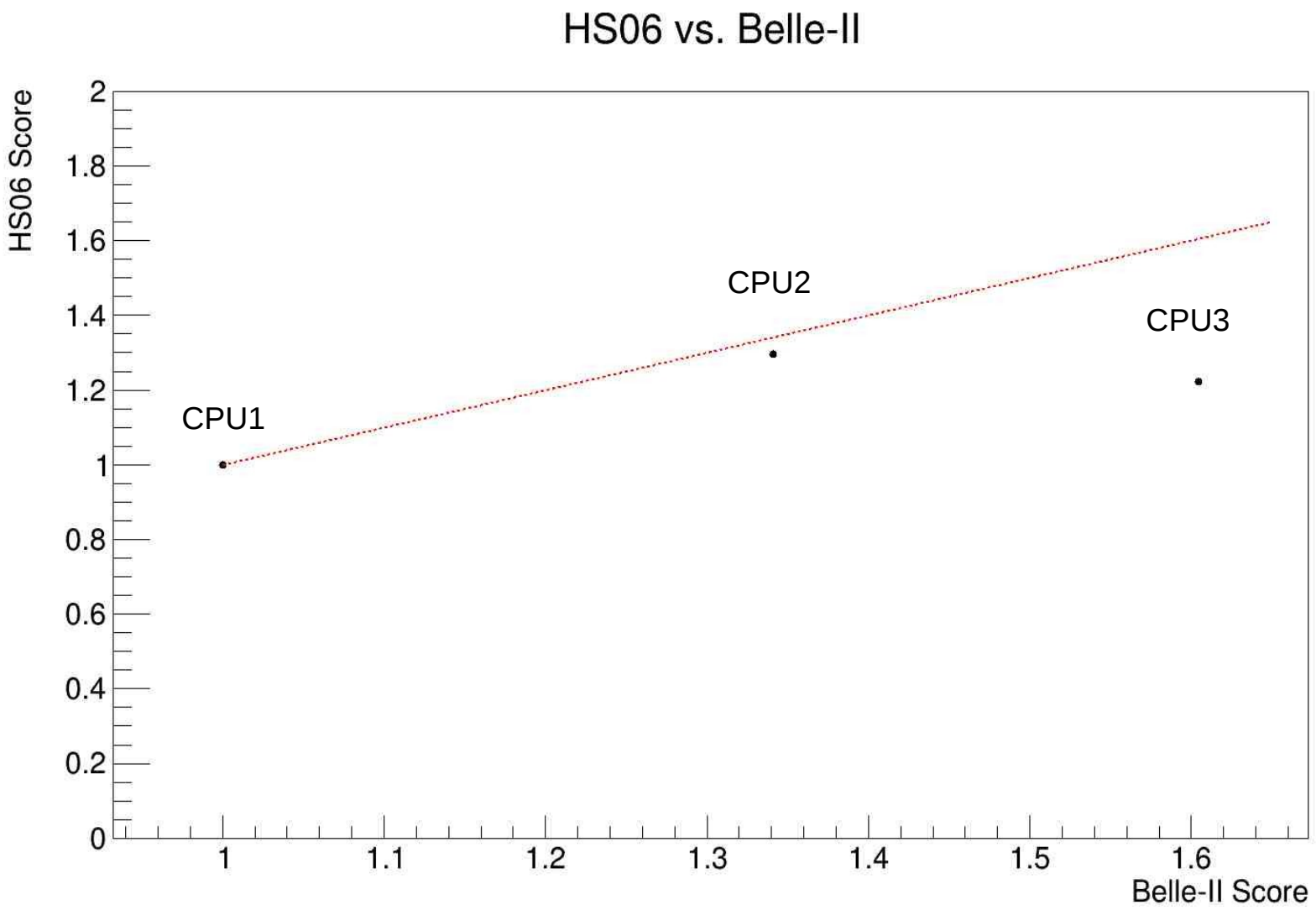
CPU2 = Intel Xeon Gold 6226 CPU, 2.7 GHz, family 6, model 85, stepping 7

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

CPU2 is the newest

CPU3 has highest clock frequency

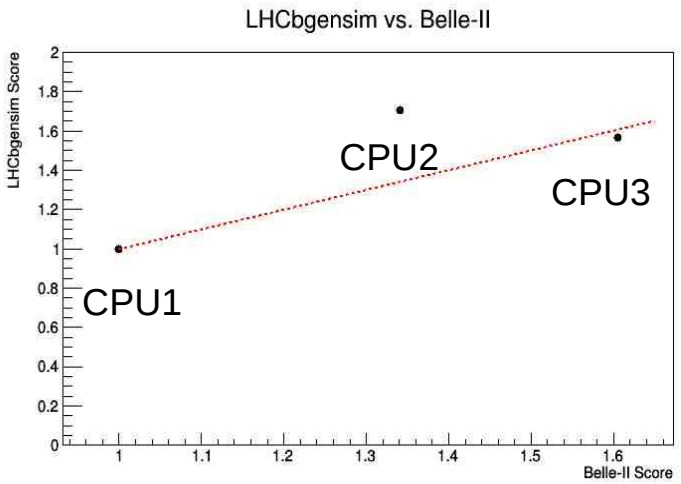
Benchmark Comparison

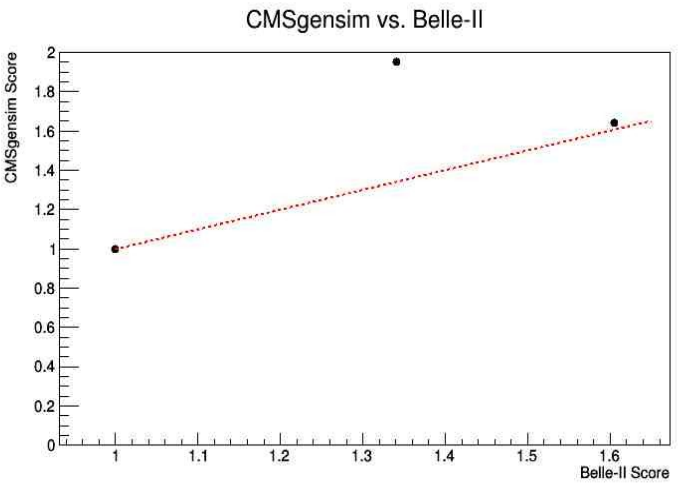


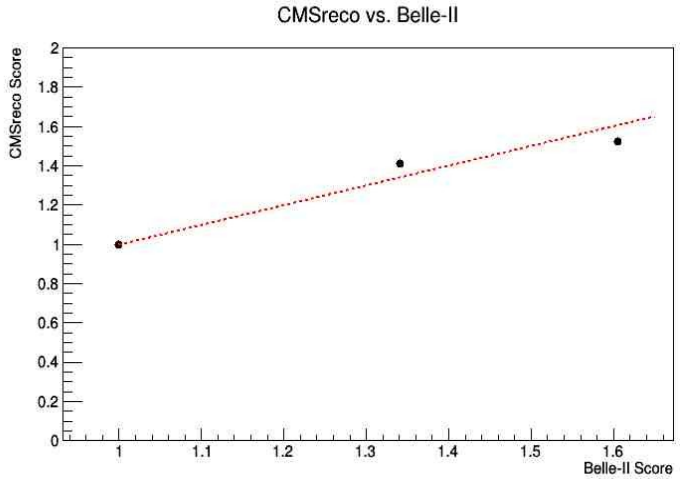
Scores normalized to CPU1

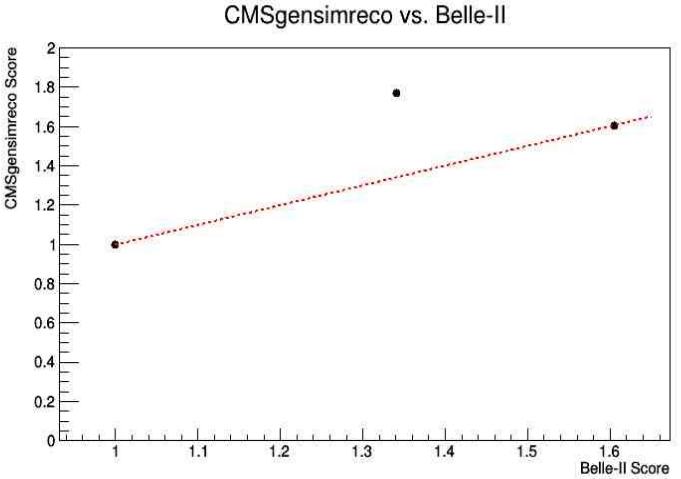
Diagonal line to guide the eye

Benchmark Comparison









Scores normalized to CPU1

Diagonal lines to guide the eye

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?

Supplementary Material

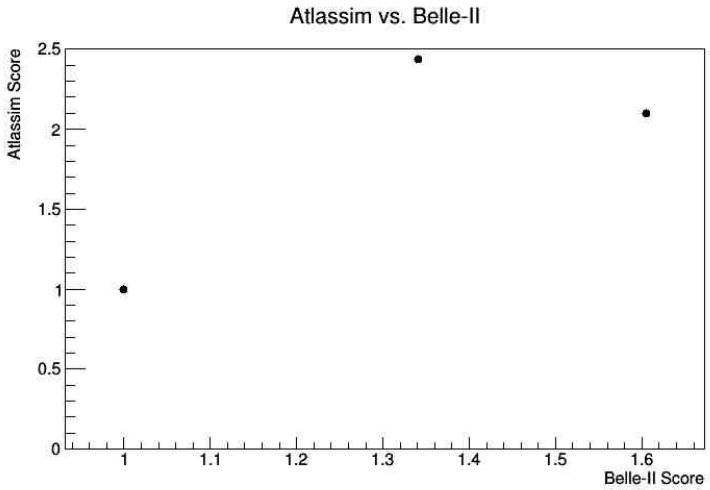
Detailed Machine Information

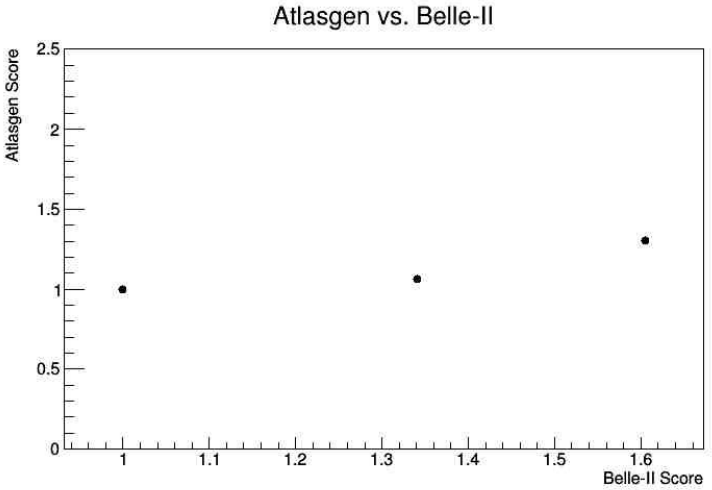
- CPU1 HV:
  - 32 cores with HT on
  - Two numa nodes
  - 10 x 8192 MB RAM, DDR3, 1600 MT/s
  - L1d cache: 32 K
  - L1i cache: 32K
  - L2 cache: 256 K
  - L3 cache: 20480 K
- CPU2 HV:
  - 48 cores with HT on
  - Two numa nodes
  - 6 x 16384 MB RAM, DDR4, 2933 MT/s
  - L1d cache: 32 K
  - L1i cache: 32K
  - 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

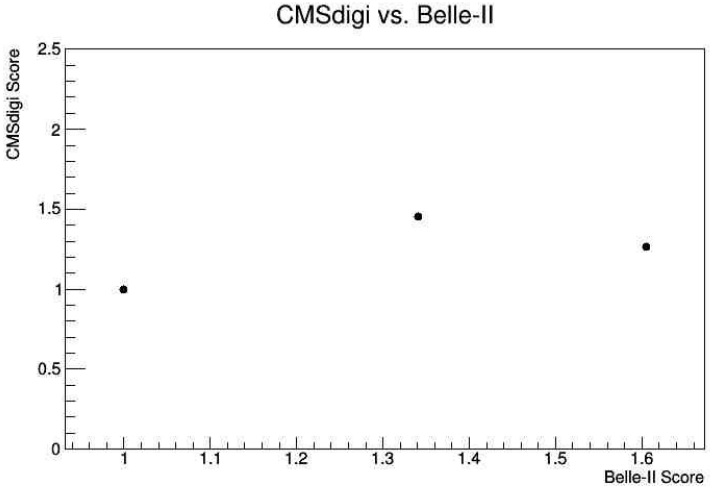
Detailed Benchmark Information

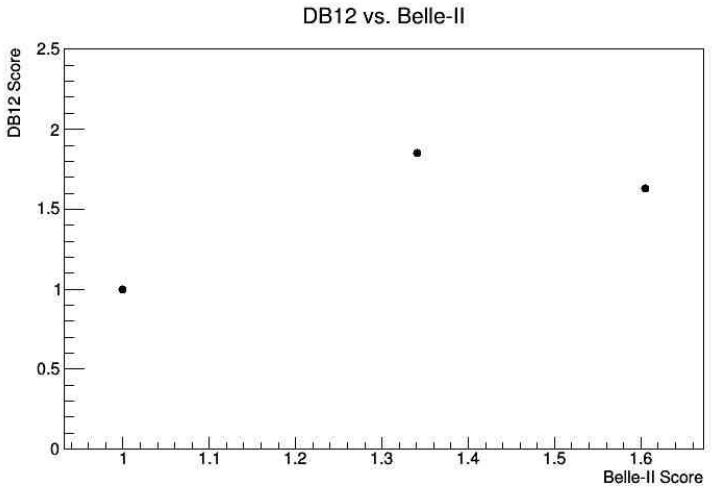
- Atlas-gen: 200 events, 1 thread, 10 minutes
- Atlas-sim: 10 events, 4 threads, ~90 minutes
- LHCb-gen-sim: 5 events, 1 thread, ~25 minutes
- CMS-reco: 50 events, 4 threads, ~10 minutes
- CMS-digi: 50 events, 4 threads, ~5 minutes
- CMS-gen-sim: 20 events, 4 threads, ~15 minutes
- Belle2-gen-sim-reco: 50 events, 4 threads, ~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

Benchmark Comparison









Runs Without Dedicated HVs