Analysis of the benchmark data

Randall Sobie University of Victoria
(on behalf of the HEPiX Benchmark Working Group)

Introduction

Data is collected from many sites and written into an Elastic Search database at CERN

The data is then written into pickle files for easier analysis

Require 5 measurement of benchmarks and workloads (except at CERN)

Workloads are run 3 times and the geometric-mean is taken minimize spurious results
[same method as used for HEPSpec06]

Some very minor clean-up cuts also applied to remove outliers

Results found at https://rjsobie.web.cern.ch/rjsobie/benchmarks.html

Jargon:
HS == HEPSpec06 (there is a 32-bit and a 64-bit version) WLCG uses the 32-bit version
SP == SPEC2017 (there is an “intrate” and “cpp” version)
System == (CPU, site, HT, cores)

Reconfirm HEPSpec06 and SPEC2017

HEPSpec06 32/64bit and SPEC2017 intrate/cpp
HEPSpec06 32bit is the WLCG standard

Tables and plots
Organized by AMD/Intel, HT (hyperthreading on/off) System = (CPU, site, HT, cores)

HEPSPEC06 32bit: 72 systems and 1778 measurements
SPEC2017 intrate: 58 systems and 1025 measurement

Not all sites had SPEC2017 licenses

HS06 32bit

2022-08-08 15:55:49
Benchmark hs06_score 32bit
Note: all values of benchmarks/core use the PHYSICAL number of cores

CPU	Architecture	Site	Physical Cores	HT	N	Benchmark mean	Benchmark std	Bmk/PCore mean	Bmk/PCore std	RAM GB/core
AMD_EPYC_7302_16-Core_Processor	Rome	CERN	32	1	24	783	1	24.46	0.03	8.2
AMD_EPYC_7313_16-Core_Processor	Milan	CaltechLIGO	32	1	2	1014	5	31.70	0.14	8.2
AMD_EPYC_7402_24-Core_Processor	Rome	CaltechLIGO	8	1	8	186	5	23.25	0.64	4.1
AMD_EPYC_7443P_24-Core_Processor	Milan	NDGF-UCPH	24	1	1	714	nan	29.76	nan	5.5
AMD_EPYC_7551P_32-Core_Processor	Naples	Nikhef	32	1	20	502	1	15.67	0.02	8.2
AMD_EPYC_7702P_64-Core_Processor	Rome	Nikhef	64	1	20	1211	5	18.91	0.08	8.3
AMD_EPYC_7742_64-Core_Processor	Rome	GridKa	128	1	100	2513	14	19.63	0.11	4.6
AMD_EPYC_7H12_64-Core_Processor	Rome	Nikhef	64	1	20	1267	6	19.79	0.09	8.3
AMD_Opteron(tm)_Processor_6174	K10	GridKa	48	1	10	347	9	7.24	0.19	2.1
Intel(R)_Xeon(R)_CPU_E5-2650_v4_@_2.20GHz	Broadwell	CERN	24	1	24	426	2	17.75	0.08	11.0

HEPSpec06 32-bit table and histograms

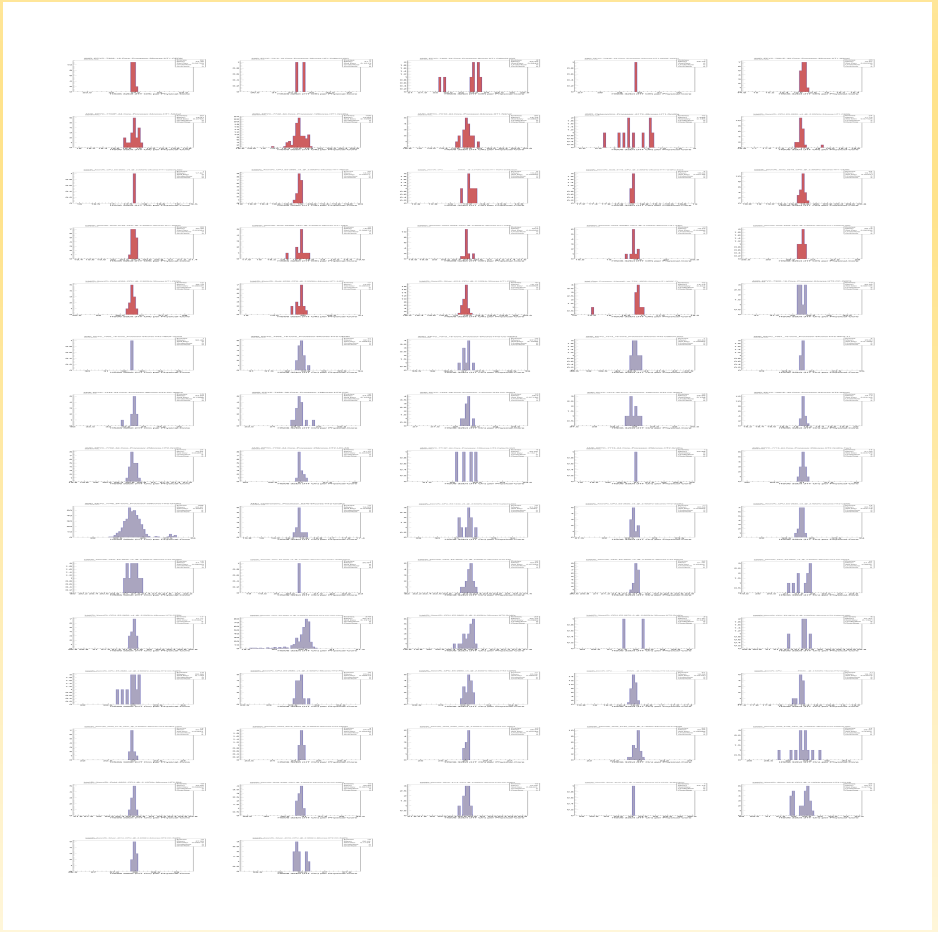
HS06 32bit

2022-08-08 15:55:49
Benchmark hs06_score 32bit
Note: all values of benchmarks/core use the PHYSICAL number of cores

CPU	Architecture	Site	Physical Cores	HT	N	Benchmark mean	Benchmark std	Bmk/PCore mean	Bmk/PCore std	RAM GB/core		
AMD_EPYC_7302_16-Core_Processor	Rome	CERN	32	1	24	783	1	24.46	0.03	8.2		
AMD_EPYC_7313_16-Core_Processor	Milan	CaltechLIGO	32	1	2	1014	5	31.70	0.14	8.2		
AMD_EPYC_7402_24-Core_Processor	Rome	CaltechLIGO	8	1	8	186	5	23.25	0.64	4.1		
AMD_EPYC_7443P_24-Core_Processor	Milan	NDGF-UCPH	24	1	1	714	nan	29.76	nan	5.5		
AMD_EPYC_7551P_32-Core_Processor	Naples	Nikhef	32	1	20	502	1	15.67	0.02	8.2		
AMD_EPYC_7702P_64-Core_Processor	Rome	Nikhef	64	1	20	1211	5	18.91	0.08	8.3		
AMD_EPYC_7742_64-Core_Processor	Rome	GridKa	128	1	100	2513	14	19.63	0.11	4.6		
AMD_EPYC_7H12_64-Core_Processor	Rome	Nikhef	64	1	20	1267	6	19.79	0.09	8.3		
AMD_Opteron(tm)_Processor_6174	K10	GridKa	48	1	10	347	9	7.24	0.19	2.1		
Intel(R)_Xeon(R)_CPU_E5-2650_v4_@_2.20GHz	Broadwell	CERN	24	1	24	426	2	17.75	0.08	11.0		
Intel(R)_Xeon(R)_CPU_E5-2650_v4_@_2.20GHz	Broadwell	CaltechLIGO	24	1	1	424	nan	17.67	nan	11.0		
Intel(R)_Xeon(R)_CPU_E5-2680_v3_@_2.50GHz	Haswell	Nikhef	24	1	20	456	1	18.98	0.03	8.2		
Intel(R)_Xeon(R)_CPU_____E5520__@_2.27GHz	NehalemEP	IN2P3-SUBATECH	8	1	6	106	0	13.23	0.06	2.0	2.0	
Intel(R)_Xeon(R)_Gold_5118_CPU_@_2.30GHz	Skylake	GridKa-Tier3	24	1	3	432	1	18.02	0.03	16.4		
Intel(R)_Xeon(R)_Gold_5218_CPU_@_2.30GHz	CascadeLake	CERN	32	1	24	632	1	19.76	0.04	6.1		
Intel(R)_Xeon(R)_Gold_6148_CPU_@_2.40GHz	Skylake	Nikhef	40	1	20	815	1	20.36	0.03	9.9		
Intel(R)_Xeon(R)_Gold_6238R_CPU_@_2.20GHz	CascadeLake	IHEP	56	1	12	1045	5	18.66	0.09	4.7	4.7	
Intel(R)_Xeon(R)_Gold_6248_CPU_@_2.50GHz	CascadeLake	IHEP	40	1	7	824	2	20.60	0.05	4.9	4.9	
Intel(R)_Xeon(R)_Gold_6258R_CPU_@_2.70GHz	CascadeLake	IHEP	56	1	11	1088	3	19.43	0.05	4.7	4.7	
Intel(R)_Xeon(R)_Gold_6326_CPU_@_2.90GHz	IceLake	CaltechLIGO	32	1	5	856	2	26.76	0.07	8.2		
Intel(R)_Xeon(R)_Gold_6326_CPU_@_2.90GHz	IceLake	CERN	32	1	12	857	2	26.79	0.06	8.2		
Intel(R)_Xeon(R)_Gold_6338_CPU_@_2.00GHz	IceLake	IHEP	64	1	17	1276	4	19.94	0.07	4.1	4.1	
Intel(R)_Xeon(R)_Silver_4216_CPU_@_2.10GHz	CascadeLake	CERN	32	1	41	613	1	19.16	0.04	6.1	6.1	
Intel_Core_Processor_(Haswell,_no_TSX,_IBRS)	Haswell	NDGF-T1	24	1	10	401	10	16.73	0.43	5.0	5.0	
AMD_EPYC_7302_16-Core_Processor	Rome	CC-IN2P3	32	2	10	1032	3	32.25	0.09	3.1		
AMD_EPYC_7302_16-Core_Processor	Rome	NDGF-UCPH	32	2	1	1039	nan	32.46	nan	2.1		
AMD_EPYC_7302_16-Core_Processor	Rome	CERN	32	2	17	1036	2	32.37	0.07	4.1		
AMD_EPYC_7313_16-Core_Processor	Milan	CC-IN2P3	32	2	10	1186	4	37.07	0.12	4.1		
AMD_EPYC_7313_16-Core_Processor	Milan	CaltechLIGO	32	2	7	1300	3	40.63	0.11	4.1		
AMD_EPYC_7351_16-Core_Processor	Naples	INFN-T1	32	2	3	762	1	23.81	0.02	4.1		
AMD_EPYC_7443_24-Core_Processor	Milan	CC-IN2P3	48	2	10	1617	6	33.69	0.12	5.5		
AMD_EPYC_7452_32-Core_Processor	Rome	PIC	64	2	16	1574	7	24.59	0.11	2.1		
AMD_EPYC_7453_28-Core_Processor	Milan	CC-IN2P3	56	2	10	1585	4	28.30	0.08	4.7		
AMD_EPYC_7513_32-Core_Processor	Milan	CC-IN2P3	64	2	10	1853	7	28.96	0.11	4.1		
AMD_EPYC_7551P_32-Core_Processor	Naples	Nikhef	32	2	20	612	1	19.13	0.03	4.1		
AMD_EPYC_7702_64-Core_Processor	Rome	GridKa	128	2	24	2644	6	20.65	0.05	2.3		
AMD_EPYC_7702_64-Core_Processor	Rome	IJCLAB	128	2	15	2689	6	21.01	0.05	2.1		
AMD_EPYC_7713P_64-Core_Processor	Milan	CaltechLIGO	64	2	4	1426	11	22.29	0.18	2.1		
AMD_EPYC_7713_64-Core_Processor	Milan	GridKa	128	2	1	2686	nan	20.98	nan	4.1		
AMD_EPYC_7713_64-Core_Processor	Milan	GridKa-Tier3	128	2	14	2691	5	21.02	0.04	4.1	4.1	
AMD_EPYC_7742_64-Core_Processor	Rome	GridKa	128	2	408	2920	26	22.81	0.20	2.3	2.3	2.3
AMD_Opteron(tm)_Processor_6376	Piledriver	GridKa	32	2	12	529	1	16.53	0.04	2.1		
Intel(R)_Xeon(R)_CPU_E3-1240_v5_@_3.50GHz	Skylake	CaltechLIGO	4	2	10	126	1	31.58	0.33	4.1		
Intel(R)_Xeon(R)_CPU_E5-2630_v3_@_2.40GHz	Haswell	GridKa	16	2	11	361	1	22.59	0.05	3.1		
Intel(R)_Xeon(R)_CPU_E5-2630_v3_@_2.40GHz	Haswell	CERN	16	2	18	365	1	22.79	0.04	4.1		
Intel(R)_Xeon(R)_CPU_E5-2630_v4_@_2.20GHz	Broadwell	GridKa	20	2	12	423	2	21.15	0.10	2.5		
Intel(R)_Xeon(R)_CPU_E5-2630_v4_@_2.20GHz	Broadwell	CCIPL-SUBATECH	20	2	1	417	nan	20.84	nan	3.3		
Intel(R)_Xeon(R)_CPU_E5-2640_v3_@_2.60GHz	Haswell	PIC	16	2	16	372	1	23.24	0.08	2.1		
Intel(R)_Xeon(R)_CPU_E5-2650_v4_@_2.20GHz	Broadwell	Nikhef	24	2	20	523	1	21.78	0.03	4.1		
Intel(R)_Xeon(R)_CPU_E5-2650_v4_@_2.20GHz	Broadwell	CC-IN2P3	24	2	10	519	7	21.62	0.28	3.1		
Intel(R)_Xeon(R)_CPU_E5-2650_v4_@_2.20GHz	Broadwell	CERN	24	2	17	521	1	21.71	0.04	5.5		
Intel(R)_Xeon(R)_CPU_E5-2660_0_@_2.20GHz	SandyBridgeEP	CA-UVic-Cloud	16	2	378	327	3	20.47	0.19	3.1	3.1	3.1
Intel(R)_Xeon(R)_CPU_E5-2665_0_@_2.40GHz	SandyBridgeEP	GridKa	16	2	23	332	2	20.72	0.10	2.1	1.5	
Intel(R)_Xeon(R)_CPU_E5-2670_0_@_2.60GHz	SandyBridgeEP	GridKa	16	2	2	351	8	21.91	0.49	1.0	2.1	
Intel(R)_Xeon(R)_CPU_E5-2670_0_@_2.60GHz	SandyBridgeEP	CaltechLIGO	16	2	6	347	2	21.67	0.14	4.1		
Intel(R)_Xeon(R)_CPU_E5-2680_v2_@_2.80GHz	IvyBridgeEP	CC-IN2P3	20	2	10	459	3	22.96	0.15	3.3		
Intel(R)_Xeon(R)_CPU_E5-2680_v4_@_2.40GHz	Broadwell	PIC	28	2	16	662	2	23.64	0.07	2.4		
Intel(R)_Xeon(R)_CPU_E5-2680_v4_@_2.40GHz	Broadwell	CERN	28	2	17	660	2	23.56	0.07	4.7		
Intel(R)_Xeon(R)_CPU_____E5520__@_2.27GHz	NehalemEP	CA-UVic-Cloud	8	2	37	133	0	16.59	0.03	3.1		
Intel(R)_Xeon(R)_CPU_____E5630__@_2.53GHz	WestmereEP	GridKa	8	2	11	147	0	18.32	0.05	1.5		
Intel(R)_Xeon(R)_Gold_5118_CPU_@_2.30GHz	Skylake	GridKa-Tier3	24	2	12	552	1	22.99	0.05	8.2		
Intel(R)_Xeon(R)_Gold_5218_CPU_@_2.30GHz	CascadeLake	CERN	32	2	4	788	1	24.63	0.05	3.1		
Intel(R)_Xeon(R)_Gold_5320_CPU_@_2.20GHz	IceLake	CC-IN2P3	52	2	10	1354	2	26.04	0.04	5.1		
Intel(R)_Xeon(R)_Gold_6130_CPU_@_2.10GHz	Skylake	CERN	32	2	25	734	2	22.94	0.07	3.1		
Intel(R)_Xeon(R)_Gold_6136_CPU_@_3.00GHz	Skylake	CaltechLIGO	24	2	13	705	6	29.35	0.26	4.1	4.1	
Intel(R)_Xeon(R)_Gold_6252_CPU_@_2.10GHz	CascadeLake	BNL	48	2	10	1088	1	22.66	0.03	2.0		
Intel(R)_Xeon(R)_Gold_6326_CPU_@_2.90GHz	IceLake	CC-IN2P3	32	2	10	989	2	30.89	0.07	4.1		
Intel(R)_Xeon(R)_Silver_4114_CPU_@_2.20GHz	Skylake	CC-IN2P3	20	2	10	454	1	22.68	0.07	3.3		
Intel(R)_Xeon(R)_Silver_4210_CPU_@_2.20GHz	CascadeLake	CCIPL-SUBATECH	20	2	1	483	nan	24.15	nan	3.3		
Intel(R)_Xeon(R)_Silver_4216_CPU_@_2.10GHz	CascadeLake	IJCLAB	32	2	28	714	9	22.31	0.28	2.1		
Intel(R)_Xeon(R)_Silver_4314_CPU_@_2.40GHz	IceLake	CC-IN2P3	32	2	10	896	1	27.99	0.03	4.1		
Intel(R)_Xeon(R)_Silver_4316_CPU_@_2.30GHz	IceLake	CC-IN2P3	40	2	10	1058	5	26.44	0.12	3.3		

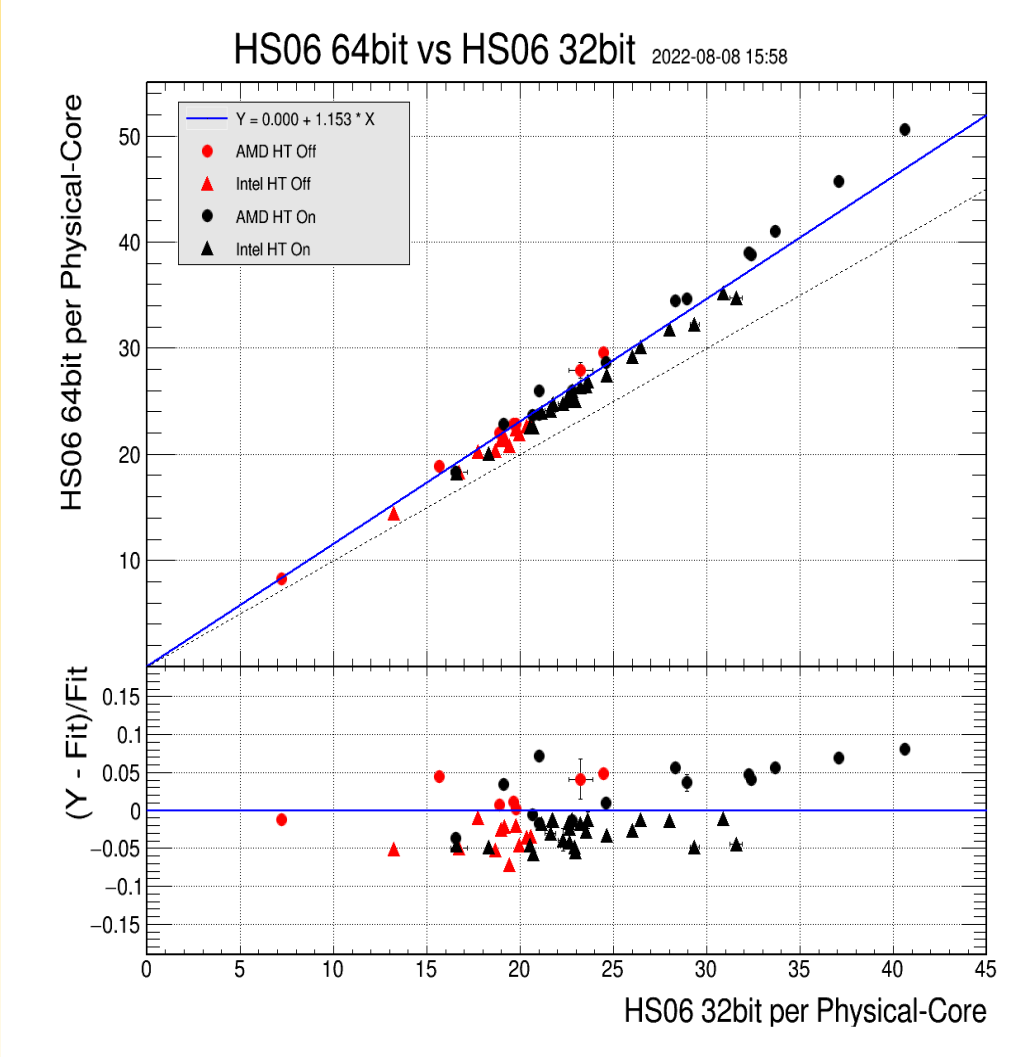
N histograms = 72
N reuslts = 1778

72 systems and 1778 measurements



Individual histograms of each system
(red = HT off). (blue = HT on)
Most results consistent to <1%

HEPSPEC06, SPEC2017 plots I



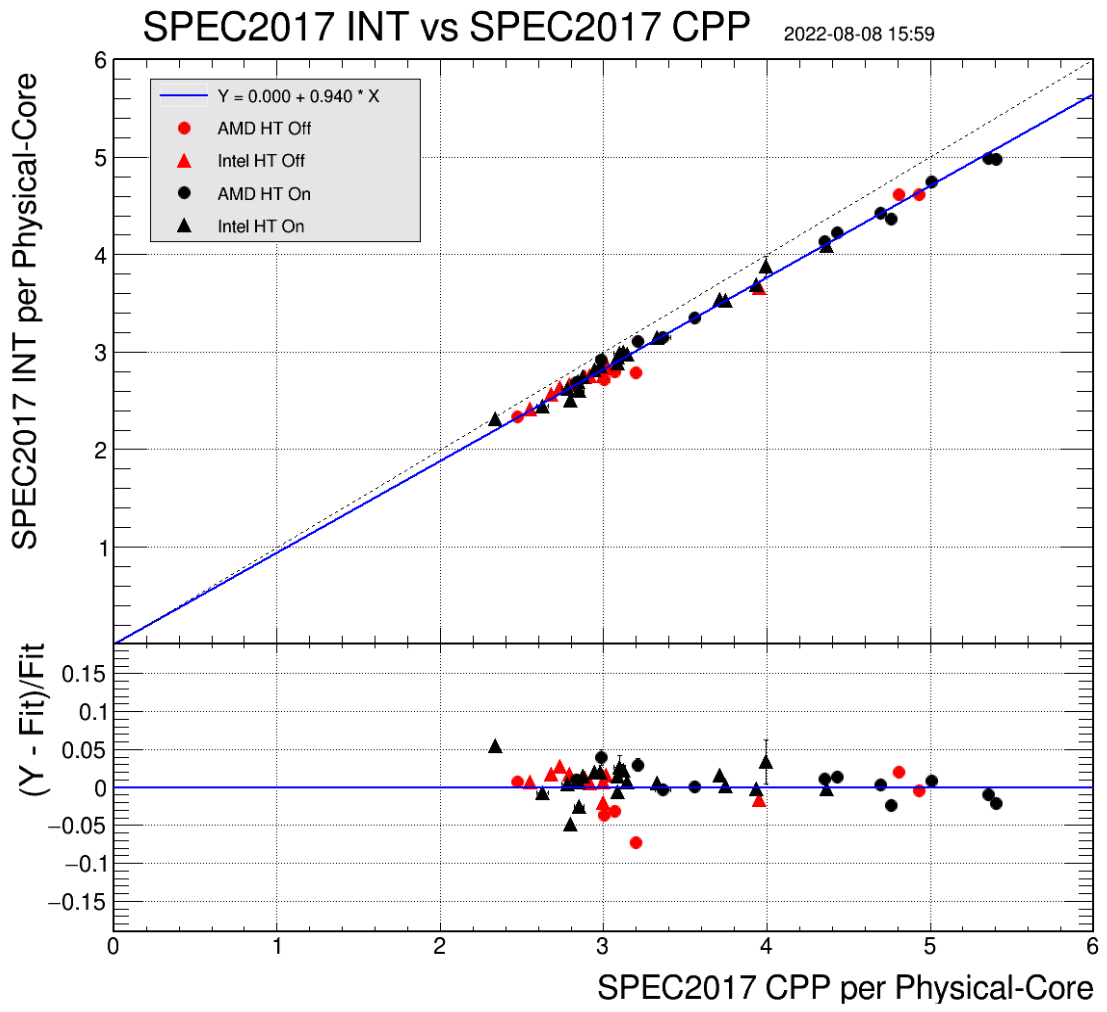
HEPSPEC06 32 vs 64 bit benchmarks
(per physical core)

Y (64bit) = 1.15 X(32bit)
Fit (blue-line) constrained to (0,0)

Red points	HT Off
Black points	HT ON
Circles	AMD
Triangles	Intel

Tables available on web site

HEPSPEC06, SPEC2017 plots II



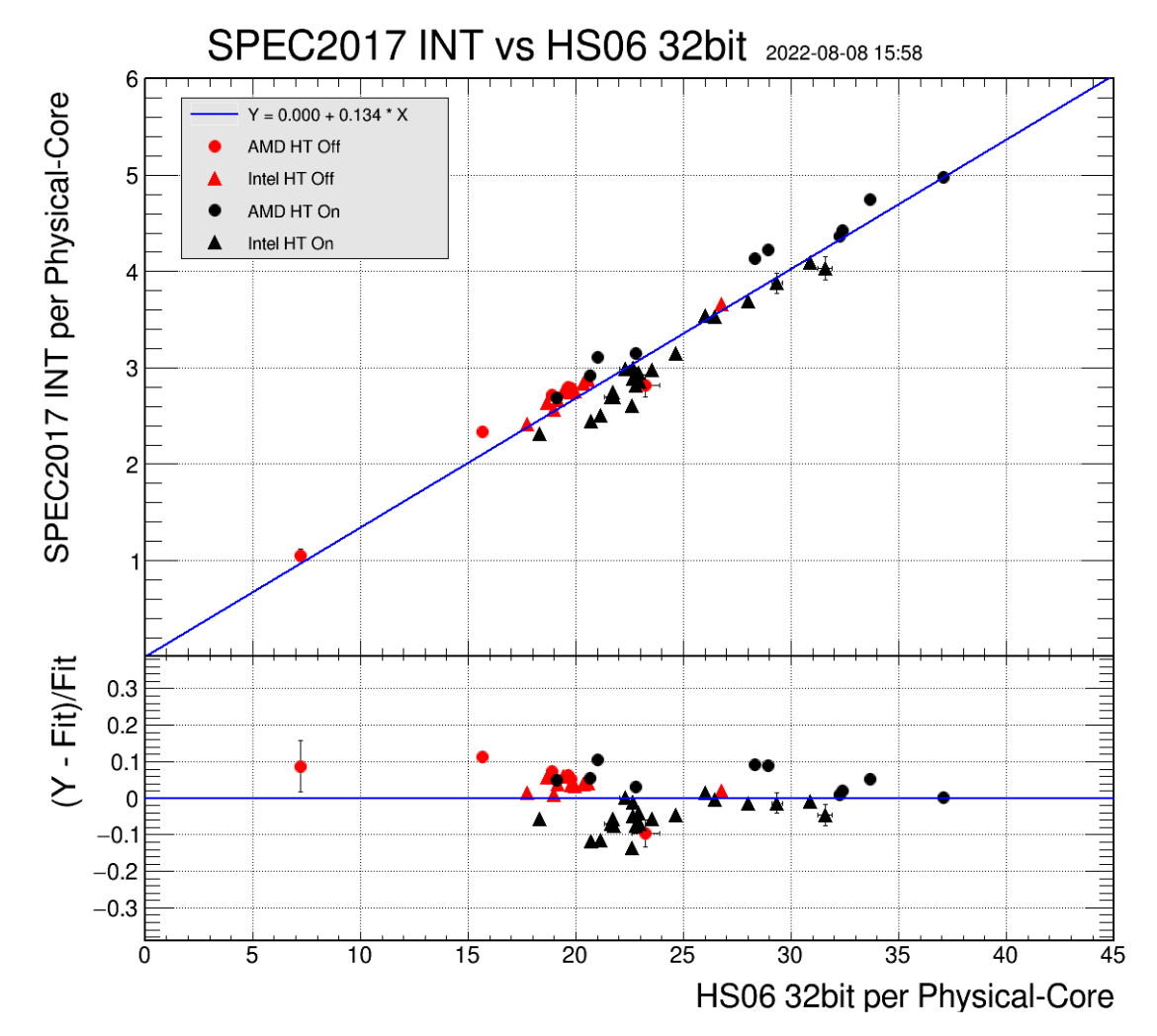
SPEC2017 intrate vs cpp
(per physical core)

Y(INT) = 0.94 X(CPP)
Fit (blue-line) constrained to (0,0)

Red points	HT Off
Black points	HT ON
Circles	AMD
Triangles	Intel

Tables available on web site

HEPSPEC06, SPEC2017 plots III



SPEC2017 intrate vs HEPSPEC06-32bit
(per physical core)

Y(INT) = 0.134 X(32bit)
Fit (blue-line) constrained to (0,0)

Red points	HT Off
Black points	HT ON
Circles	AMD
Triangles	Intel

Tables available on web site

Workloads

Run3 workloads for LHC experiments

alice_gen_sim_reco

atlas_gen_sherpa
atlas_sim_mt
atlas_reco_mt

belle2_gen_sim_reco

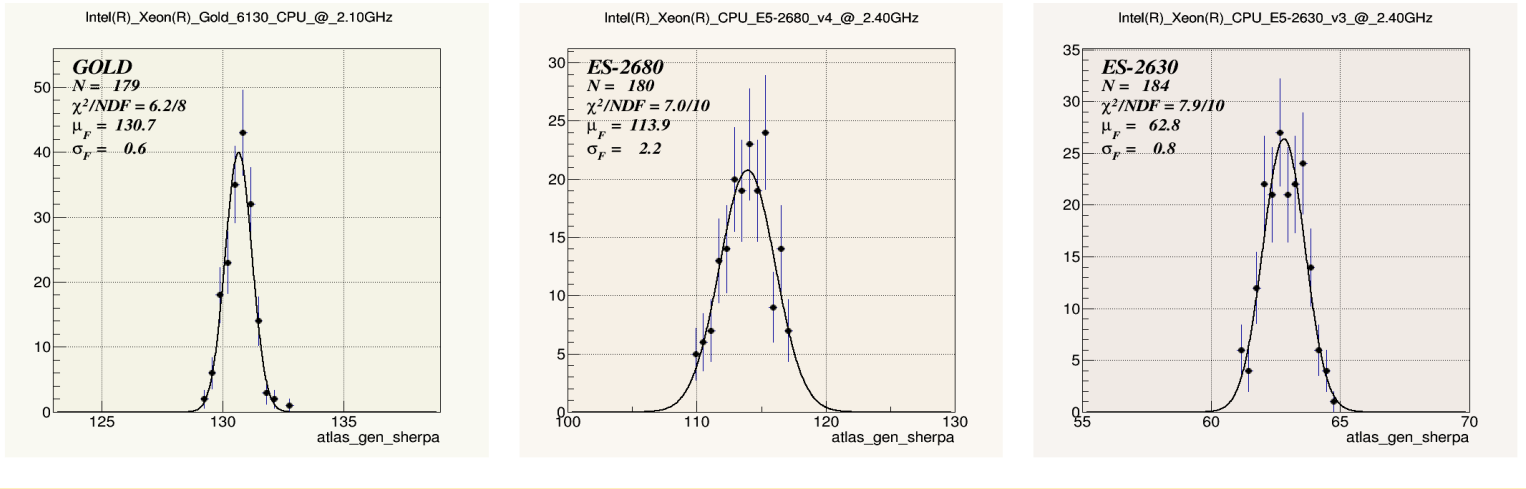
cms_reco
cms_digi
cms_gen_sim

juno_gen_sim_reco

igwn_pe (Gravity Wave)

lhcb_gen_sim

Each workload has been run and validated on a set of CERN servers



Each workload is then run on the remote systems.

Workloads were provided over a many month period
(reduce the number of CPU systems and measurements)

Example: CMS reco I

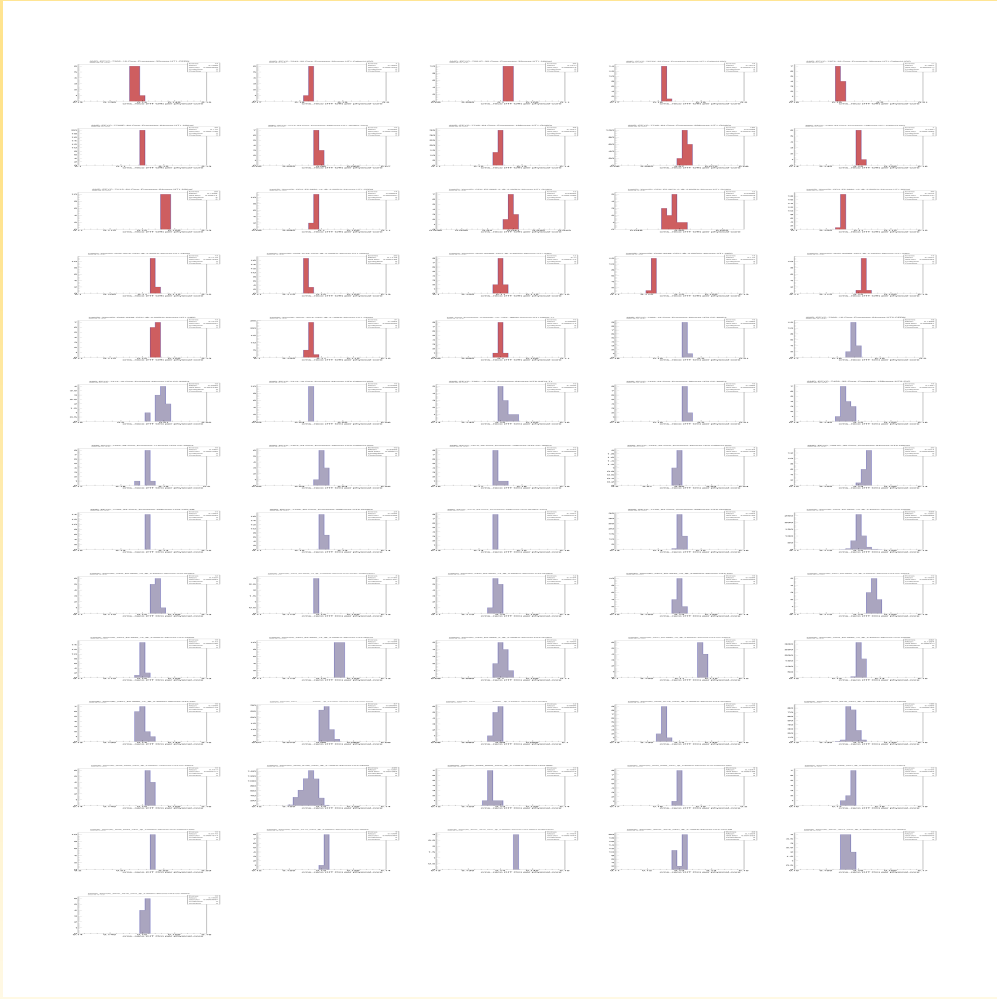
66 systems, 3000+ measurements

cms_reco

```
2022-08-10 10:51:41
hepscore_wl_scores_cms_reco_run3_bmk_reco
Note:  all values of benchmarks/core use the PHYSICAL number of cores
```

CPU	Architecture	Site	Physical Cores	HT	N	Benchmark mean	Benchmark std	Bmk/PCore mean	Bmk/PCore std	Norm Bmk mean	Norm Bmk std	RAM GB/core	
AMD_EPYC_7302_16-Core_Processor	Rome	CERN	32	1	13	4.44	0.01	0.139	0.000	1.40	0.00	8.2	
AMD_EPYC_7543_32-Core_Processor	Milan	CaltechLIGO	32	1	7	5.83	0.01	0.182	0.000	1.84	0.00	8.2	
AMD_EPYC_7551P_32-Core_Processor	Naples	Nikhef	32	1	20	3.24	0.01	0.101	0.000	1.02	0.00	8.2	
AMD_EPYC_7573X_32-Core_Processor	Milan	CaltechLIGO	64	1	15	11.61	0.02	0.181	0.000	1.83	0.00	8.2	
AMD_EPYC_75F3_32-Core_Processor	Milan	CaltechLIGO	32	1	11	6.10	0.01	0.191	0.000	1.93	0.00	8.2	
AMD_EPYC_7702P_64-Core_Processor	Rome	Nikhef	64	1	20	7.36	0.01	0.115	0.000	1.16	0.00	8.3	
AMD_EPYC_7713_64-Core_Processor	Milan	GridKa-Tier3	256	1	18	15.23	0.04	0.059	0.000	0.60	0.00	4.1	
AMD_EPYC_7742_64-Core_Processor	Rome	GridKa	128	1	48	15.97	0.06	0.125	0.000	1.26	0.00	4.6	
AMD_EPYC_7742_64-Core_Processor	Rome	GridKa	256	1	240	18.17	0.11	0.071	0.000	0.72	0.00	2.3	2.3
AMD_EPYC_7763_64-Core_Processor	Milan	CaltechLIGO	128	1	7	19.22	0.02	0.150	0.000	1.52	0.00	4.1	
AMD_EPYC_7H12_64-Core_Processor	Rome	Nikhef	64	1	20	7.91	0.01	0.124	0.000	1.25	0.00	8.3	
Intel(R)_Xeon(R)_CPU_E5-2650_v4_@_2.20GHz	Broadwell	CERN	24	1	13	2.38	0.01	0.099	0.000	1.00	0.00	11.0	
Intel(R)_Xeon(R)_CPU_E5-2665_0_@_2.40GHz	SandyBridgeEP	GridKa	32	1	24	1.31	0.00	0.041	0.000	0.41	0.00	1.5	
Intel(R)_Xeon(R)_CPU_E5-2670_0_@_2.60GHz	SandyBridgeEP	GridKa	32	1	24	1.59	0.01	0.050	0.000	0.50	0.00	2.1	
Intel(R)_Xeon(R)_CPU_E5-2680_v3_@_2.50GHz	Haswell	Nikhef	24	1	20	2.58	0.01	0.108	0.000	1.09	0.00	8.2	
Intel(R)_Xeon(R)_Gold_5218_CPU_@_2.30GHz	CascadeLake	CERN	32	1	13	3.58	0.01	0.112	0.000	1.13	0.00	6.1	
Intel(R)_Xeon(R)_Gold_6148_CPU_@_2.40GHz	Skylake	Nikhef	40	1	20	4.71	0.01	0.118	0.000	1.19	0.00	9.9	
Intel(R)_Xeon(R)_Gold_6238R_CPU_@_2.20GHz	CascadeLake	IHEP	56	1	12	6.16	0.02	0.110	0.000	1.11	0.00	4.7	
Intel(R)_Xeon(R)_Gold_6248_CPU_@_2.50GHz	CascadeLake	IHEP	40	1	13	4.64	0.01	0.116	0.000	1.17	0.00	4.9	
Intel(R)_Xeon(R)_Gold_6258R_CPU_@_2.70GHz	CascadeLake	IHEP	56	1	13	6.76	0.01	0.121	0.000	1.22	0.00	4.7	
Intel(R)_Xeon(R)_Gold_6338_CPU_@_2.00GHz	IceLake	IHEP	64	1	13	7.80	0.01	0.122	0.000	1.23	0.00	4.1	
Intel(R)_Xeon(R)_Silver_4216_CPU_@_2.10GHz	CascadeLake	CERN	32	1	31	3.47	0.01	0.108	0.000	1.09	0.00	6.1	6.1
Intel_Core_Processor_(Haswell,_no_TSX,_IBRS)	Haswell	NDGF-T1	24	1	10	2.40	0.01	0.100	0.000	1.01	0.00	5.0	
AMD_EPYC_7302_16-Core_Processor	Rome	CC-IN2P3	32	2	10	6.29	0.01	0.197	0.000	1.99	0.00	3.1	
AMD_EPYC_7302_16-Core_Processor	Rome	CERN	32	2	18	5.88	0.02	0.184	0.001	1.86	0.01	4.1	
AMD_EPYC_7313_16-Core_Processor	Milan	CC-IN2P3	32	2	10	6.69	0.04	0.209	0.001	2.11	0.01	4.1	
AMD_EPYC_7313_16-Core_Processor	Milan	CaltechLIGO	32	2	10	7.77	0.01	0.243	0.000	2.45	0.00	4.1	
AMD_EPYC_7351_16-Core_Processor	Naples	INFN-T1	32	2	10	4.82	0.02	0.151	0.001	1.52	0.01	4.1	
AMD_EPYC_7443_24-Core_Processor	Milan	CC-IN2P3	48	2	10	9.44	0.01	0.197	0.000	1.99	0.00	5.5	
AMD_EPYC_7452_32-Core_Processor	Rome	PIC	64	2	15	9.48	0.05	0.148	0.001	1.50	0.01	2.1	
AMD_EPYC_7453_28-Core_Processor	Milan	CC-IN2P3	56	2	10	10.42	0.04	0.186	0.001	1.88	0.01	4.7	
AMD_EPYC_74F3_24-Core_Processor	Milan	CaltechLIGO	24	2	10	5.64	0.02	0.235	0.001	2.38	0.01	2.7	
AMD_EPYC_7513_32-Core_Processor	Milan	CC-IN2P3	64	2	10	11.15	0.05	0.174	0.001	1.76	0.01	4.1	
AMD_EPYC_7543_32-Core_Processor	Milan	CaltechLIGO	32	2	3	7.02	0.01	0.219	0.000	2.22	0.00	8.2	
AMD_EPYC_7551P_32-Core_Processor	Naples	Nikhef	32	2	20	4.20	0.02	0.131	0.000	1.33	0.00	4.1	
AMD_EPYC_7702_64-Core_Processor	Rome	IJCLAB	128	2	14	17.45	0.04	0.136	0.000	1.38	0.00	2.1	2.1
AMD_EPYC_7702_64-Core_Processor	Rome	GridKa	128	2	24	16.07	0.06	0.126	0.000	1.27	0.00	2.3	2.3
AMD_EPYC_7713_64-Core_Processor	Milan	GridKa-Tier3	128	2	18	18.40	0.03	0.144	0.000	1.45	0.00	4.1	
AMD_EPYC_7742_64-Core_Processor	Rome	GridKa	128	2	240	18.60	0.05	0.145	0.000	1.47	0.00	2.3	
Intel(R)_Xeon(R)_CPU_E5-2630_v3_@_2.40GHz	Haswell	CERN	16	2	459	1.92	0.01	0.120	0.001	1.21	0.01	4.1	
Intel(R)_Xeon(R)_CPU_E5-2630_v3_@_2.40GHz	Haswell	GridKa	16	2	12	1.95	0.01	0.122	0.001	1.23	0.01	3.1	
Intel(R)_Xeon(R)_CPU_E5-2630_v4_@_2.20GHz	Broadwell	CCIPL-SUBATECH	20	2	3	2.38	0.00	0.119	0.000	1.20	0.00	3.3	
Intel(R)_Xeon(R)_CPU_E5-2630_v4_@_2.20GHz	Broadwell	GridKa	20	2	12	2.39	0.01	0.119	0.001	1.21	0.01	2.5	
Intel(R)_Xeon(R)_CPU_E5-2640_v3_@_2.60GHz	Haswell	PIC	16	2	16	2.08	0.01	0.130	0.000	1.31	0.00	2.1	
Intel(R)_Xeon(R)_CPU_E5-2650_v4_@_2.20GHz	Broadwell	CC-IN2P3	24	2	10	2.93	0.01	0.122	0.000	1.24	0.00	3.1	
Intel(R)_Xeon(R)_CPU_E5-2650_v4_@_2.20GHz	Broadwell	CERN	24	2	18	2.88	0.01	0.120	0.000	1.21	0.00	5.5	
Intel(R)_Xeon(R)_CPU_E5-2650_v4_@_2.20GHz	Broadwell	Nikhef	24	2	20	2.95	0.01	0.123	0.000	1.24	0.00	4.1	
Intel(R)_Xeon(R)_CPU_E5-2665_0_@_2.40GHz	SandyBridgeEP	GridKa	16	2	24	1.60	0.01	0.100	0.001	1.01	0.01	2.1	
Intel(R)_Xeon(R)_CPU_E5-2680_v2_@_2.80GHz	IvyBridgeEP	CC-IN2P3	20	2	10	2.27	0.01	0.114	0.000	1.15	0.00	3.3	
Intel(R)_Xeon(R)_CPU_E5-2680_v4_@_2.40GHz	Broadwell	CERN	28	2	492	3.79	0.01	0.135	0.000	1.37	0.00	4.7	
Intel(R)_Xeon(R)_CPU_E5-2680_v4_@_2.40GHz	Broadwell	PIC	28	2	16	3.92	0.02	0.140	0.001	1.41	0.01	2.4	
Intel(R)_Xeon(R)_CPU_____E5520__@_2.27GHz	NehalemEP	CA-UVic-Cloud	8	2	67	0.65	0.00	0.081	0.001	0.81	0.01	3.1	3.1
Intel(R)_Xeon(R)_CPU_____E5630__@_2.53GHz	WestmereEP	GridKa	8	2	12	0.72	0.00	0.090	0.000	0.91	0.00	1.5	
Intel(R)_Xeon(R)_Gold_5118_CPU_@_2.30GHz	Skylake	GridKa	24	2	12	3.30	0.01	0.138	0.000	1.39	0.00	8.2	
Intel(R)_Xeon(R)_Gold_5218_CPU_@_2.30GHz	CascadeLake	CERN	32	2	196	4.45	0.02	0.139	0.001	1.40	0.01	3.1	3.1
Intel(R)_Xeon(R)_Gold_5320_CPU_@_2.20GHz	IceLake	CC-IN2P3	52	2	10	7.86	0.02	0.151	0.000	1.53	0.00	5.1	
Intel(R)_Xeon(R)_Gold_6130_CPU_@_2.10GHz	Skylake	CERN	32	2	495	4.10	0.03	0.128	0.001	1.29	0.01	3.1	
Intel(R)_Xeon(R)_Gold_6252_CPU_@_2.10GHz	CascadeLake	BNL	48	2	10	6.18	0.03	0.129	0.001	1.30	0.01	2.0	
Intel(R)_Xeon(R)_Gold_6326_CPU_@_2.90GHz	IceLake	CaltechLIGO	32	2	9	5.91	0.00	0.185	0.000	1.87	0.00	4.1	
Intel(R)_Xeon(R)_Gold_6326_CPU_@_2.90GHz	IceLake	CC-IN2P3	32	2	10	5.55	0.03	0.173	0.001	1.75	0.01	4.1	
Intel(R)_Xeon(R)_Gold_6334_CPU_@_3.60GHz	IceLake	CaltechLIGO	16	2	10	3.48	0.00	0.217	0.000	2.19	0.00	8.2	
Intel(R)_Xeon(R)_Silver_4114_CPU_@_2.20GHz	Skylake	CC-IN2P3	20	2	10	2.62	0.01	0.131	0.000	1.32	0.00	3.3	
Intel(R)_Xeon(R)_Silver_4210_CPU_@_2.20GHz	CascadeLake	IN2P3-SUBATECH	20	2	3	2.85	0.00	0.142	0.000	1.44	0.00	3.3	
Intel(R)_Xeon(R)_Silver_4216_CPU_@_2.10GHz	CascadeLake	IJCLAB	32	2	33	4.17	0.04	0.130	0.001	1.32	0.01	2.1	
Intel(R)_Xeon(R)_Silver_4314_CPU_@_2.40GHz	IceLake	CC-IN2P3	32	2	10	5.06	0.02	0.158	0.001	1.60	0.01	4.1	
Intel(R)_Xeon(R)_Silver_4316_CPU_@_2.30GHz	IceLake	CC-IN2P3	40	2	10	6.02	0.02	0.150	0.000	1.52	0.00	3.3	

```
Sanity checks:
N histograms =    66
N results =    3046
```



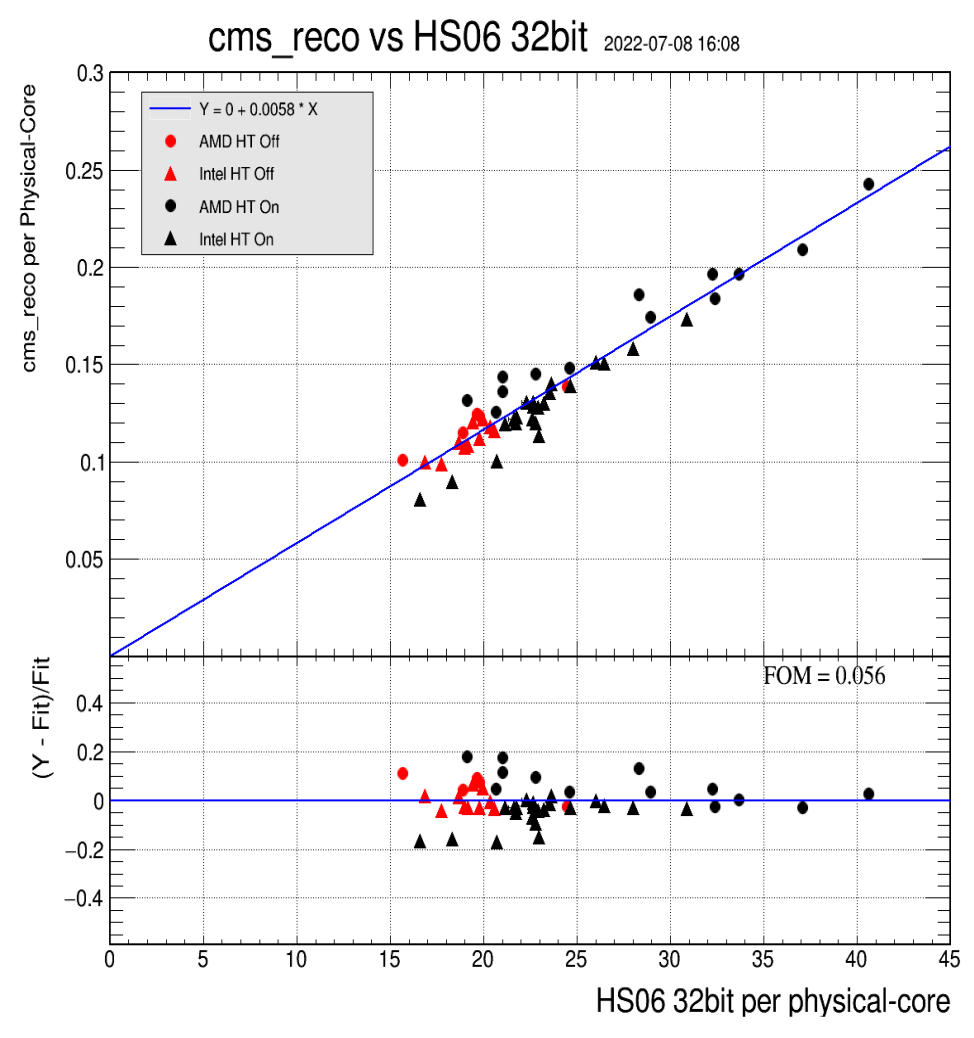
Example: CMS reco II (table of HT off)

cms_reco

2022-08-10 10:51:41
hepscore_wl_scores_cms_reco_run3_bmk_reco
Note: all values of benchmarks/core use the PHYSICAL number of cores

CPU	Architecture	Site	Physical Cores	HT	N	Benchmark mean	Benchmark std	Bmk/PCore mean	Bmk/PCore std	Norm Bmk mean	Norm Bmk std	RAM GB/core	
AMD_EPYC_7302_16-Core_Processor	Rome	CERN	32	1	13	4.44	0.01	0.139	0.000	1.40	0.00	8.2	
AMD_EPYC_7543_32-Core_Processor	Milan	CaltechLIGO	32	1	7	5.83	0.01	0.182	0.000	1.84	0.00	8.2	
AMD_EPYC_7551P_32-Core_Processor	Naples	Nikhef	32	1	20	3.24	0.01	0.101	0.000	1.02	0.00	8.2	
AMD_EPYC_7573X_32-Core_Processor	Milan	CaltechLIGO	64	1	15	11.61	0.02	0.181	0.000	1.83	0.00	8.2	
AMD_EPYC_75F3_32-Core_Processor	Milan	CaltechLIGO	32	1	11	6.10	0.01	0.191	0.000	1.93	0.00	8.2	
AMD_EPYC_7702P_64-Core_Processor	Rome	Nikhef	64	1	20	7.36	0.01	0.115	0.000	1.16	0.00	8.3	
AMD_EPYC_7713_64-Core_Processor	Milan	GridKa-Tier3	256	1	18	15.23	0.04	0.059	0.000	0.60	0.00	4.1	
AMD_EPYC_7742_64-Core_Processor	Rome	GridKa	128	1	48	15.97	0.06	0.125	0.000	1.26	0.00	4.6	
AMD_EPYC_7742_64-Core_Processor	Rome	GridKa	256	1	240	18.17	0.11	0.071	0.000	0.72	0.00	2.3	2.3
AMD_EPYC_7763_64-Core_Processor	Milan	CaltechLIGO	128	1	7	19.22	0.02	0.150	0.000	1.52	0.00	4.1	
AMD_EPYC_7H12_64-Core_Processor	Rome	Nikhef	64	1	20	7.91	0.01	0.124	0.000	1.25	0.00	8.3	
Intel(R)_Xeon(R)_CPU_E5-2650_v4_@_2.20GHz	Broadwell	CERN	24	1	13	2.38	0.01	0.099	0.000	1.00	0.00	11.0	
Intel(R)_Xeon(R)_CPU_E5-2665_0_@_2.40GHz	SandyBridgeEP	GridKa	32	1	24	1.31	0.00	0.041	0.000	0.41	0.00	1.5	
Intel(R)_Xeon(R)_CPU_E5-2670_0_@_2.60GHz	SandyBridgeEP	GridKa	32	1	24	1.59	0.01	0.050	0.000	0.50	0.00	2.1	
Intel(R)_Xeon(R)_CPU_E5-2680_v3_@_2.50GHz	Haswell	Nikhef	24	1	20	2.58	0.01	0.108	0.000	1.09	0.00	8.2	
Intel(R)_Xeon(R)_Gold_5218_CPU_@_2.30GHz	CascadeLake	CERN	32	1	13	3.58	0.01	0.112	0.000	1.13	0.00	6.1	
Intel(R)_Xeon(R)_Gold_6148_CPU_@_2.40GHz	Skylake	Nikhef	40	1	20	4.71	0.01	0.118	0.000	1.19	0.00	9.9	
Intel(R)_Xeon(R)_Gold_6238R_CPU_@_2.20GHz	CascadeLake	IHEP	56	1	12	6.16	0.02	0.110	0.000	1.11	0.00	4.7	
Intel(R)_Xeon(R)_Gold_6248_CPU_@_2.50GHz	CascadeLake	IHEP	40	1	13	4.64	0.01	0.116	0.000	1.17	0.00	4.9	
Intel(R)_Xeon(R)_Gold_6258R_CPU_@_2.70GHz	CascadeLake	IHEP	56	1	13	6.76	0.01	0.121	0.000	1.22	0.00	4.7	
Intel(R)_Xeon(R)_Gold_6338_CPU_@_2.00GHz	IceLake	IHEP	64	1	13	7.80	0.01	0.122	0.000	1.23	0.00	4.1	
Intel(R)_Xeon(R)_Silver_4216_CPU_@_2.10GHz	CascadeLake	CERN	32	1	31	3.47	0.01	0.108	0.000	1.09	0.00	6.1	6.1
Intel_Core_Processor_(Haswell,_no_TSX,_IBRS)	Haswell	NDGF-T1	24	1	10	2.40	0.01	0.100	0.000	1.01	0.00	5.0	

Workloads vs HEPSpec06 and SPEC2017



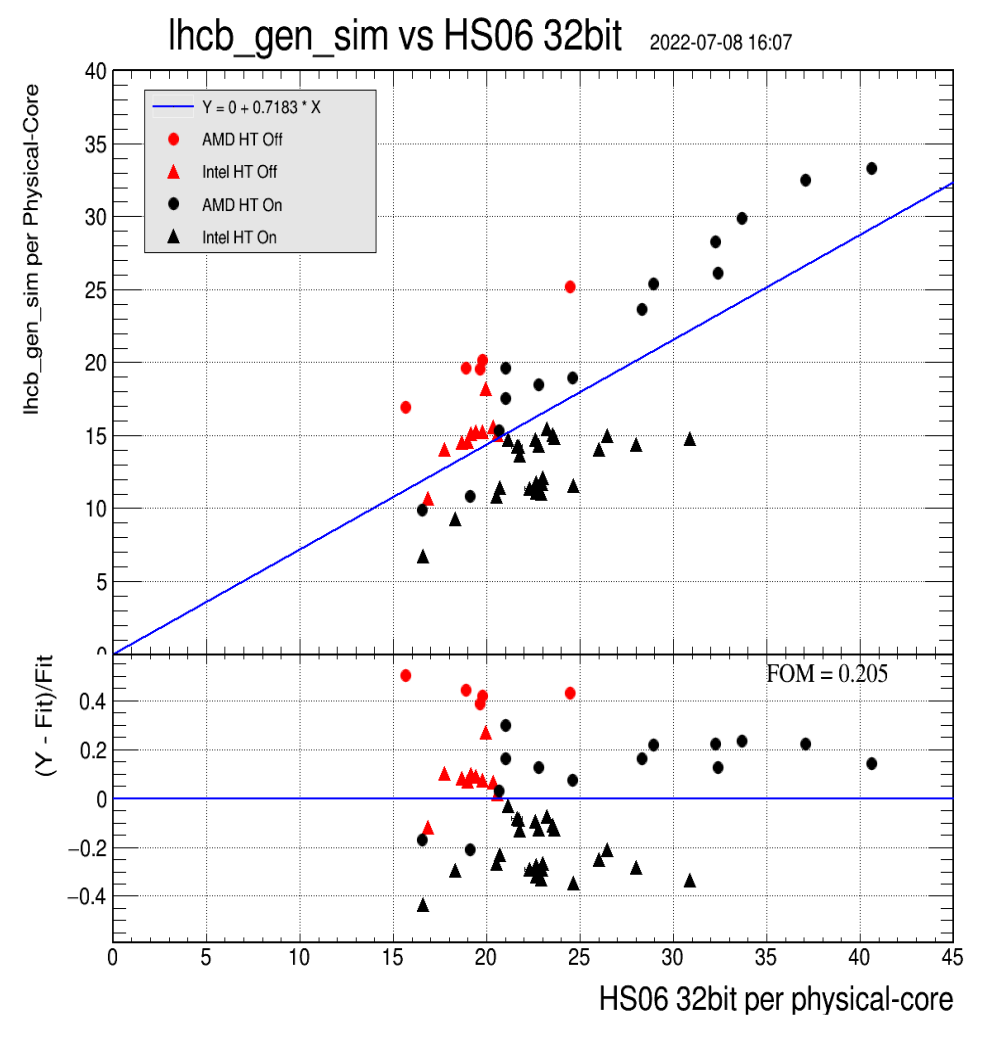
Plots of Workload results (events/s) vs HEPSpec06
Normalized to the number of physical cores

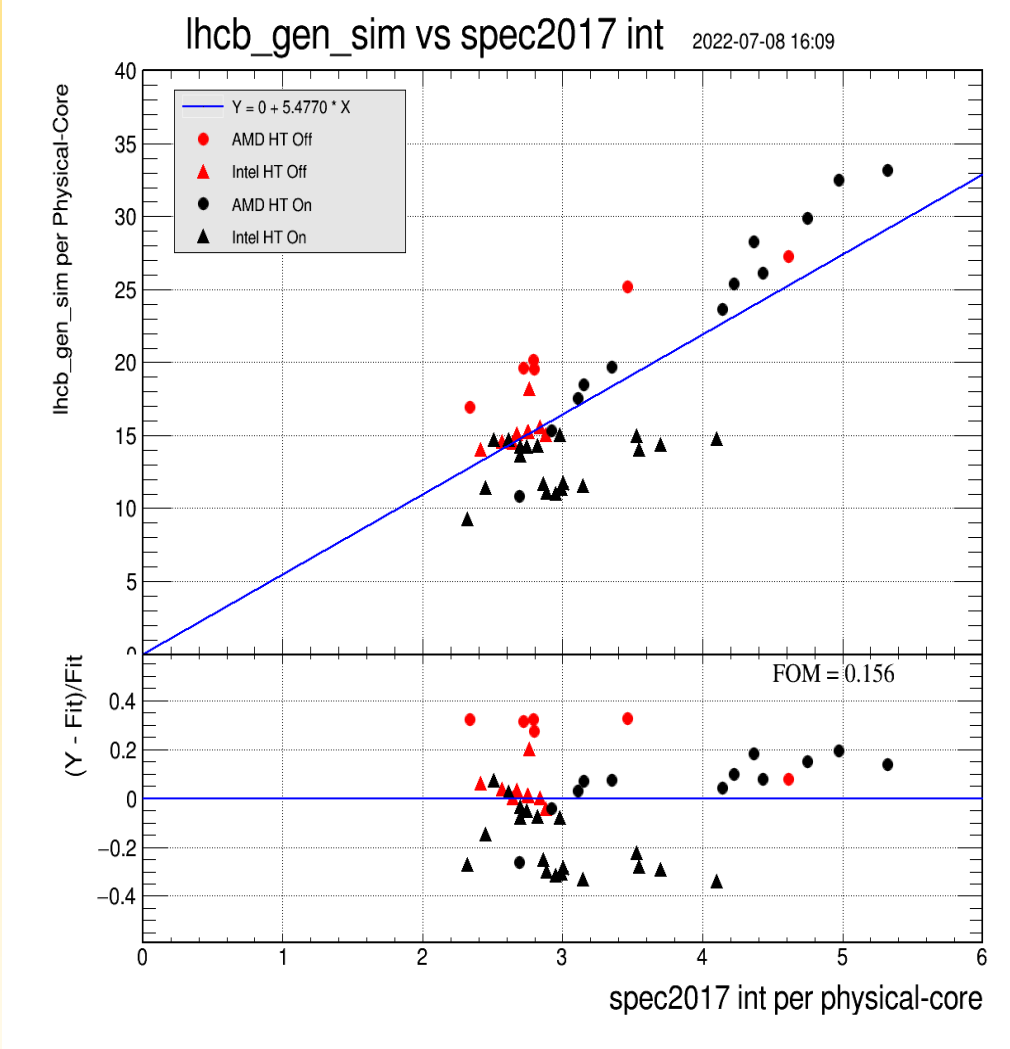
Red	HT Off
Black	HT On
Circle	AMD
Triangle	Intel

Measured deviation in y-axis is used as a metric (FOM)

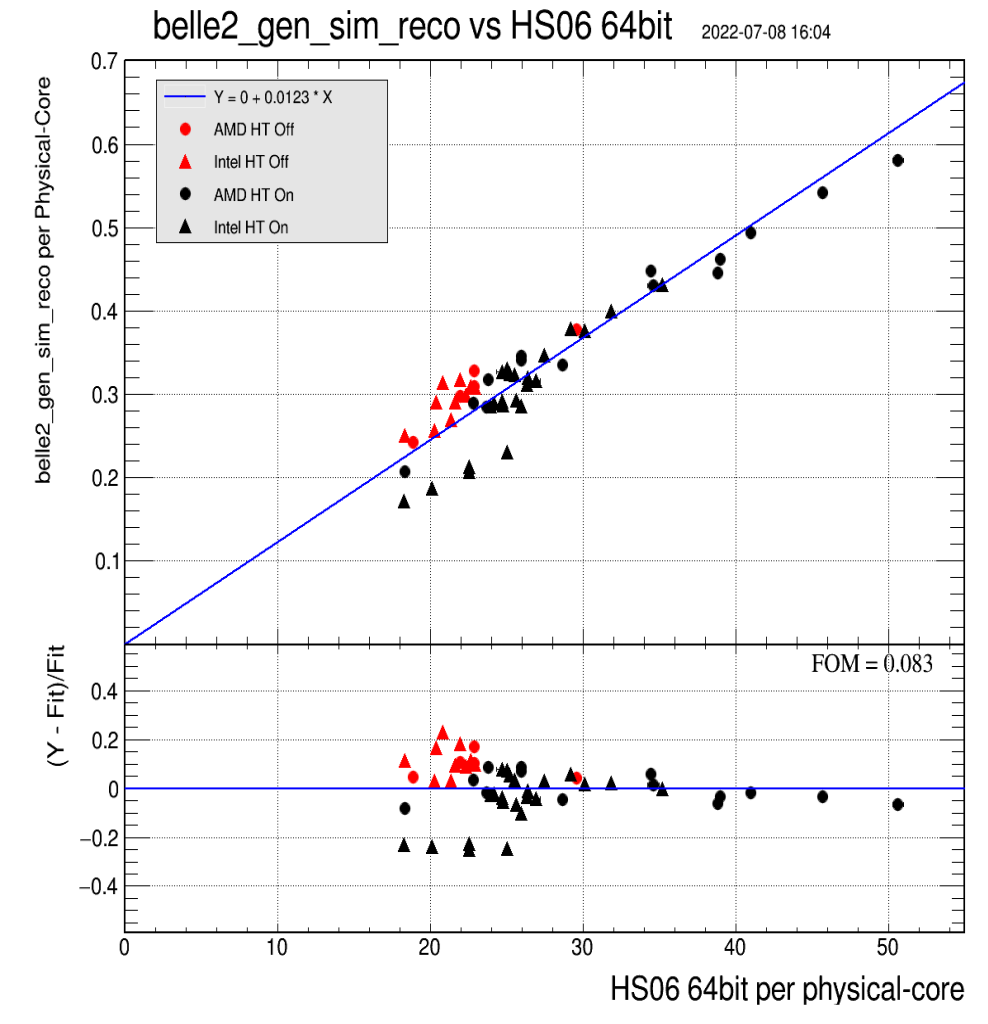
Plots and tables of each of the 11 workloads vs 4 benchmarks

Example: LHCb (gen_sim) vs HS06-32 and SP-Int





Impact of hyper-threading

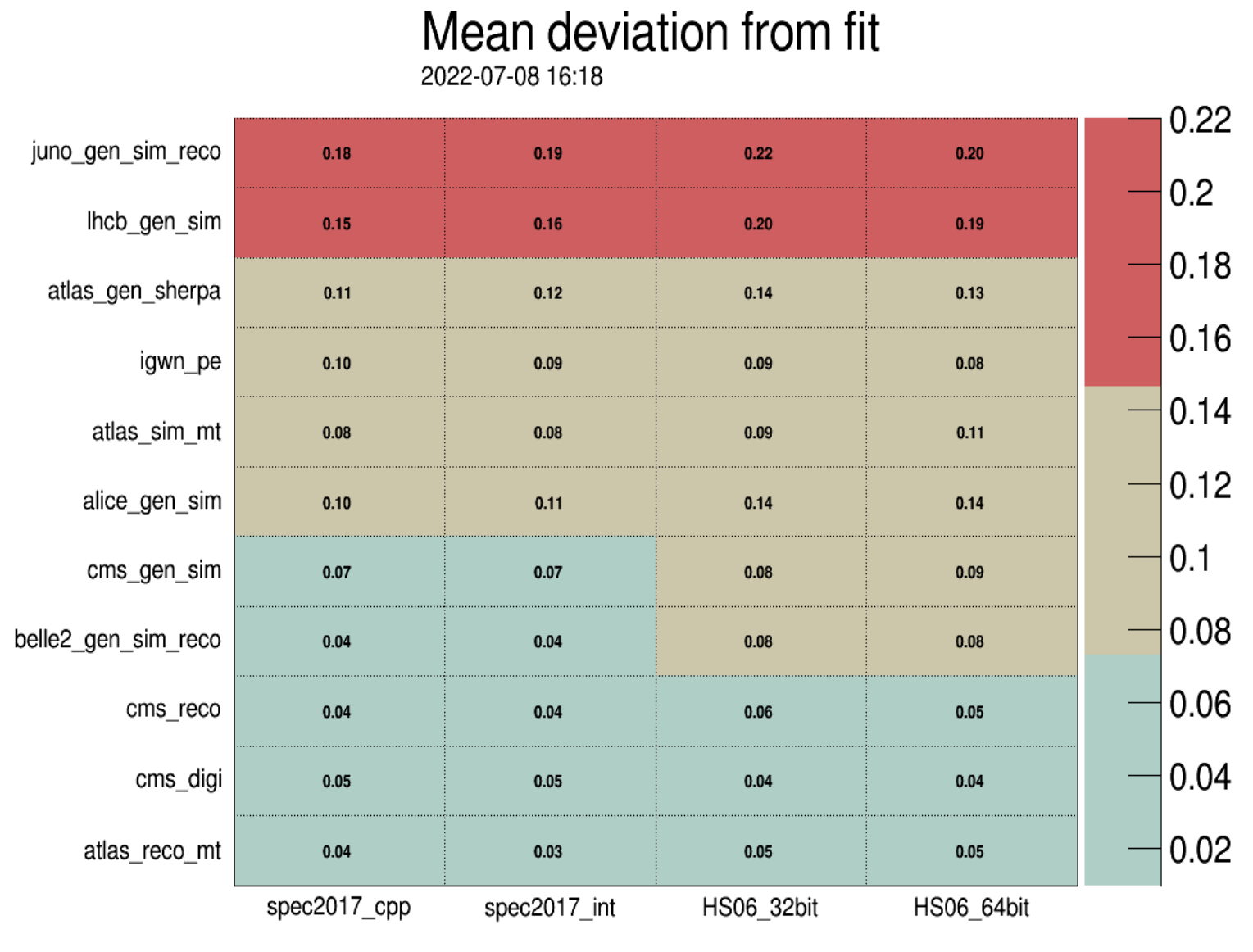


Observation:

Some workloads have a higher benchmark relative to HS06 with HT off

HT off red
HT on black

Workloads vs HS/SP - Mean deviation from fit



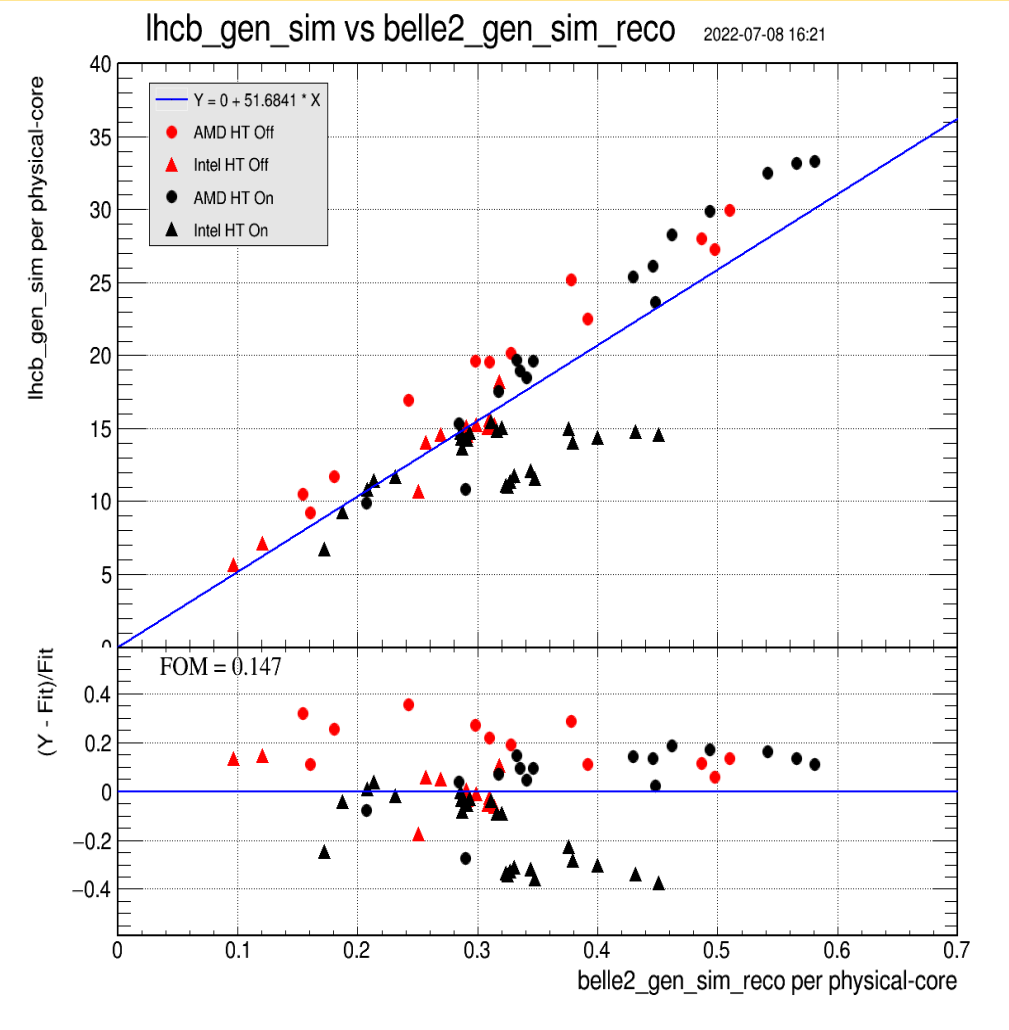
Workloads are more correlated with SPEC2017 than HEPSpec06

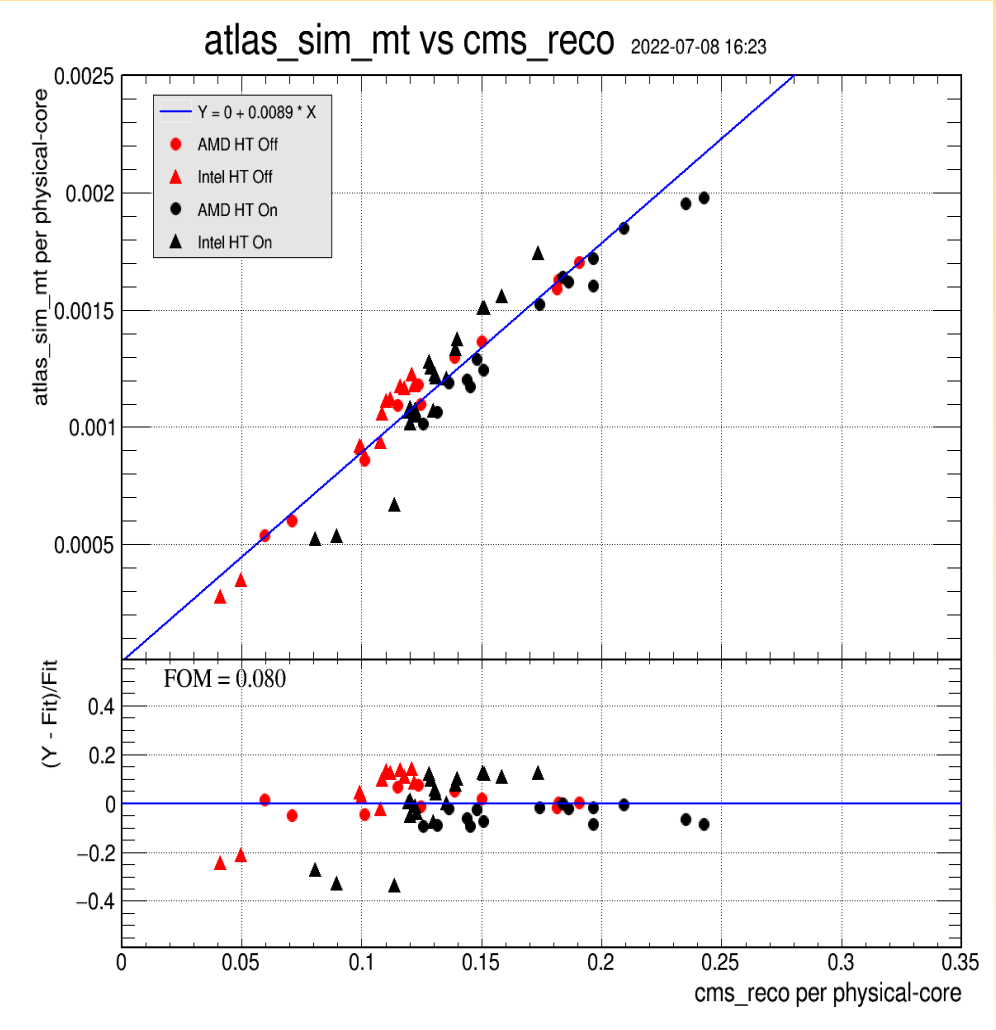
Conclude that the workloads are not wildly inconsistent with HS/SP

Consider the "deviation" from HS/SP as a feature of the workload

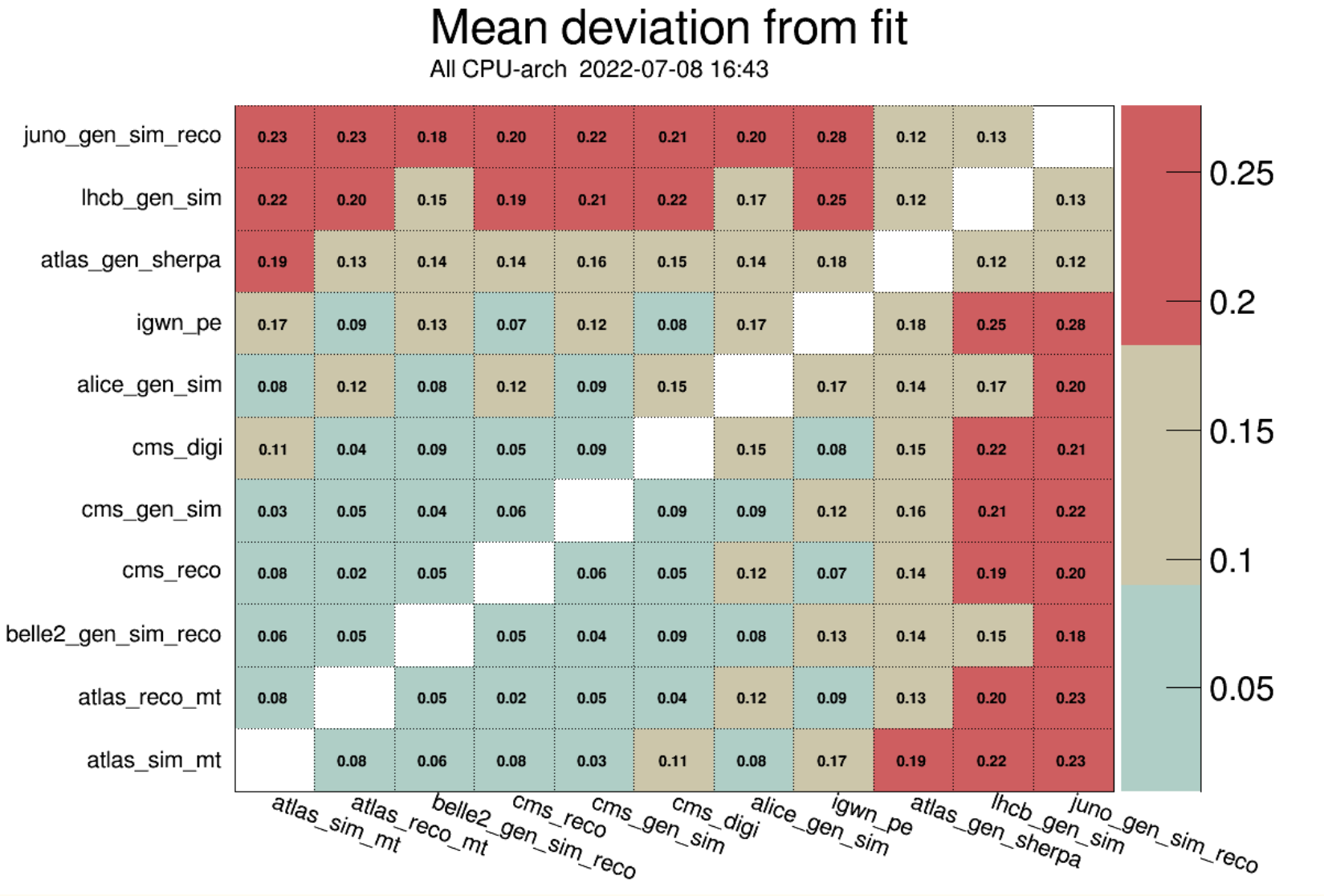
Workloads vs Workloads

50 combinations





W vs W - mean deviation from fits

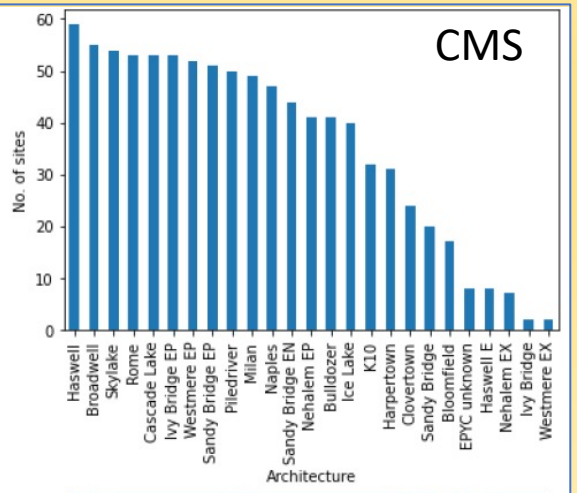


Matrix gives an indication of the correlation between the workloads

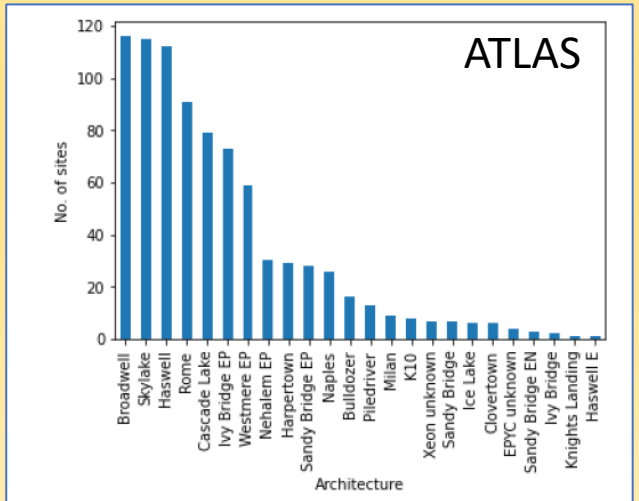
Could be used to help determine optimal workloads for HEPScore

Should we drop some workloads that are highly correlated with each other?
(speed up the time to run HEPScore)

W vs W - Top 5 CPU architectures



Arch	Lead site	Jobs at lead site
Rome	T2_CH_CERN	1097604
Broadwell	T2_CH_CERN	964962
Cascade Lake	T2_CH_CERN	772727
Haswell	T1_US_FNAL	716740
Milan	T2_US_Florida	581064
Skylake	T2_CH_CERN	352998
Piledriver	T1_US_FNAL	240529
Naples	T1_US_FNAL	238835
Ivy Bridge EP	T3_US_OSG	184682
Ice Lake	T2_US_MIT	105120
Sandy Bridge EP	T2_EE_Estonia	74821
Westmere EP	T2_US_MIT	55724
Sandy Bridge EN	T2_US_Vanderbilt	51268
Nehalem EP	T2_ES_CIEMAT	27562
K10	T2_US_Nebraska	21554
Bulldozer	T2_DE_RWTH	20043
Sandy Bridge	T3_US_Colorado	11611
Harpertown	T2_DE_RWTH	11078
Clovertown	T2_DE_RWTH	10814
EPYC unknown	T2_UK_SGrid_RALPP	10515
Bloomfield	T3_US_Colorado	9588
Haswell E	T3_US_Colorado	2418
Nehalem EX	T3_US_OSG	1286
Ivy Bridge	T2_HU_Budapest	253
Westmere EX	T2_US_Wisconsin	185



Arch	Lead site	Jobs at lead site
Rome	Vega_MCORE	2935887
Cascade Lake	CERN-T0	2117166
Skylake	IN2P3-CC	1723182
Broadwell	BNL	1406386
Ice Lake	TOKYO	1065133
Naples	BNL	915110
Sandy Bridge EP	RRC-KI-T1	383141
Haswell	RRC-KI-T1	352611
Nehalem EP	TW-FTT	332688
Ivy Bridge EP	IN2P3-CC	270132
Bulldozer	CYFRONET	213434
EPYC unknown	UIO_CLOUD	183310
Westmere EP	IHEP	175322
Piledriver	INFN-COSENZA-RECAS	165096
Sandy Bridge EN	DESY-HH	126822
Xeon unknown	GOOGLE_BULK	112081
K10	IN2P3-LPC-MUC2A	109464
Harpertown	IFIC	107506
Milan	DESY-HH	107020
Knights Landing	NERSC_Cori_p2_mcore	37756
Haswell E	UKI-NORTHGRID-SHEF-HEP	22229
Sandy Bridge	praguelcg2	12791
Ivy Bridge	CA-IAAS-T3	10731
Clovertown	IN2P3-LPC	7962

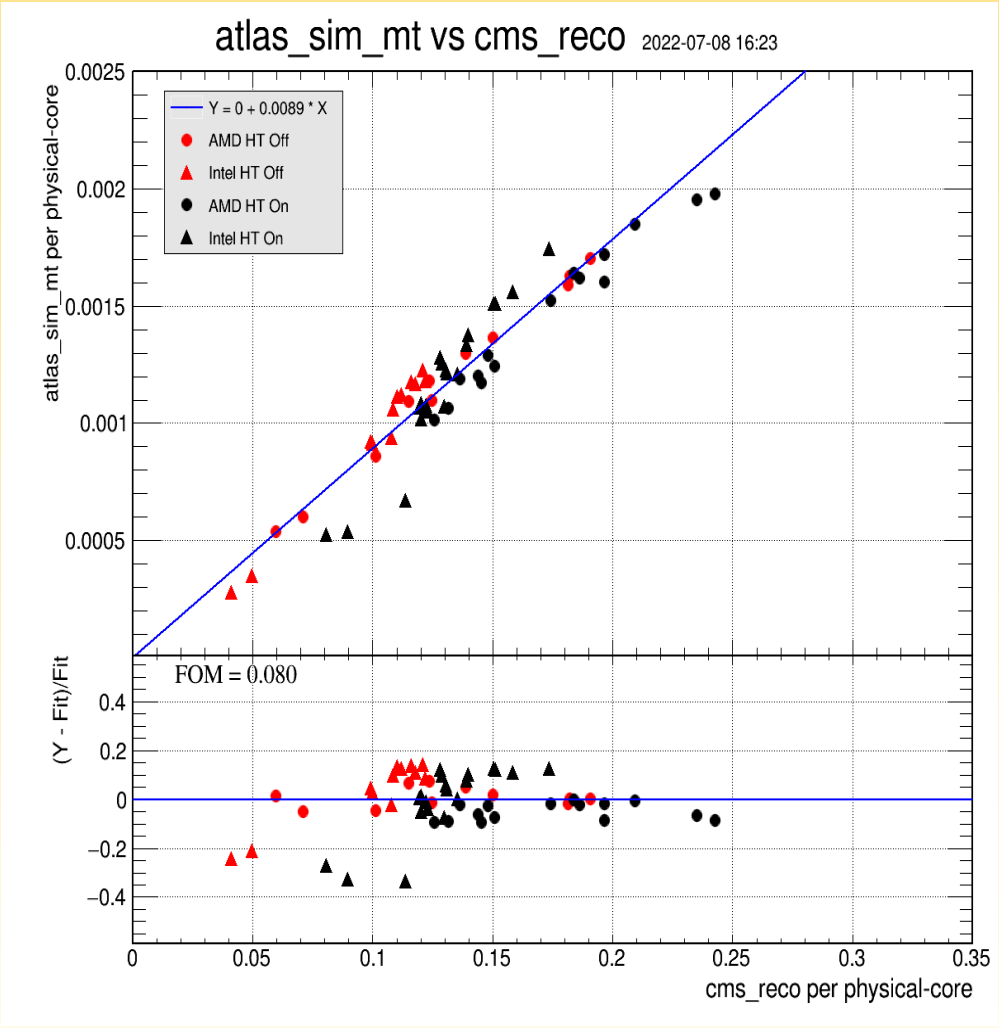
Results courtesy of Andrea Sciaba

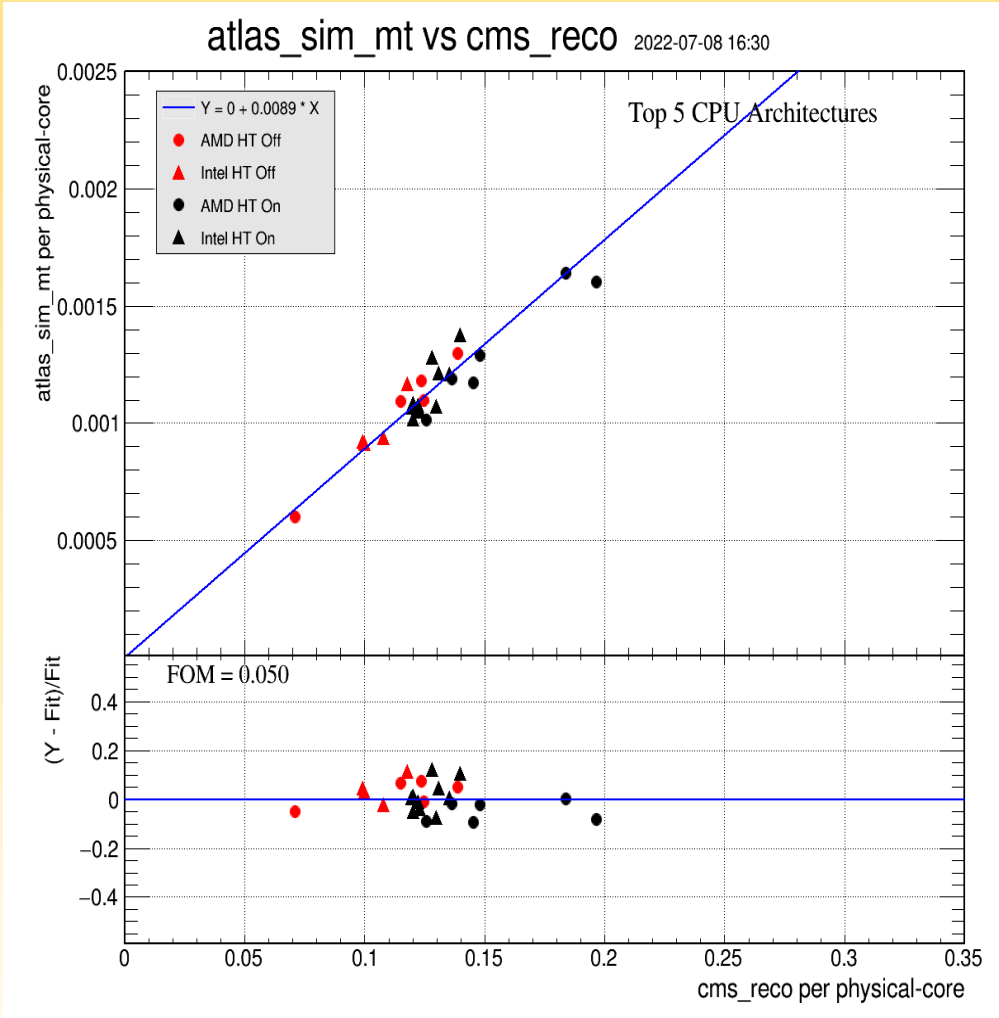
The following CPU architectures account for >80% of the ATLAS and CMS usage on the Grid:

Rome
Broadwell
Haswell
Cascade Lake
Skylake

Should we develop a HEPScore based on the performance on the Top5 architectures?
Likely these CPUs will become more prevalent in the future

ATLAS (sim_mt) vs CMS (reco) for All and Top5 CPUs





Older CPUs have larger variations

It probably does not matter to the choice of the HEPScore candidate

ATLAS (sim_mt) vs CMS (reco)

2022-07-08 16:23:51
atlas_sim_mt vs cms_reco #scale[0.5]{2022-07-08 16:23}
Note: all values of benchmarks/core use the PHYSICAL number of cores
X benchmark : cms_reco
Y benchmark : atlas_sim_mt

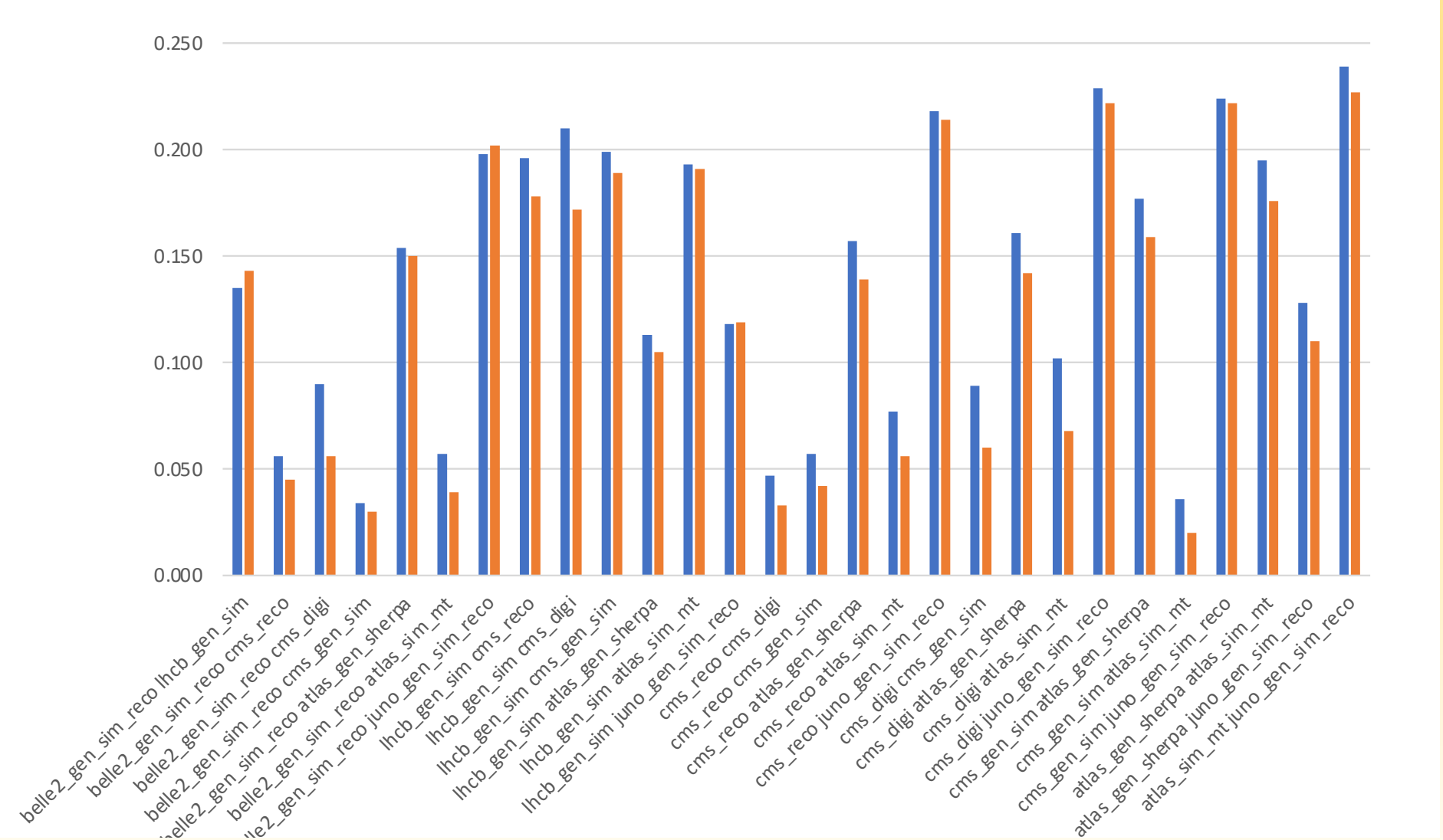
CPU	Architecture	Host	Physical Cores	HT	x-bmk/core N	x-bmk/core mean	x-bmk/core std	y-bmk/core N	y-bmk/core mean	y-bmk/core std	YFIT
AMD_EPYC_7302_16-Core_Processor	Rome	CERN	32	1	13	0.1388	0.0004	14	0.00130	0.00001	0.00124
AMD_EPYC_7543_32-Core_Processor	Milan	CaltechLIGO	32	1	7	0.1822	0.0002	10	0.00163	0.00000	0.00162
AMD_EPYC_7551P_32-Core_Processor	Naples	Nikhef	32	1	20	0.1011	0.0003	20	0.00086	0.00000	0.00090
AMD_EPYC_7573X_32-Core_Processor	Milan	CaltechLIGO	64	1	15	0.1815	0.0003	8	0.00159	0.00000	0.00162
AMD_EPYC_75F3_32-Core_Processor	Milan	CaltechLIGO	32	1	11	0.1907	0.0004	10	0.00170	0.00001	0.00170
AMD_EPYC_7702P_64-Core_Processor	Rome	Nikhef	64	1	20	0.1150	0.0002	20	0.00109	0.00000	0.00102
AMD_EPYC_7713_64-Core_Processor	Milan	GridKa-Tier3	256	1	10	0.0595	0.0002	10	0.00054	0.00000	0.00053
AMD_EPYC_7742_64-Core_Processor	Rome	GridKa	128	1	48	0.1247	0.0004	48	0.00110	0.00000	0.00111
AMD_EPYC_7742_64-Core_Processor	Rome	GridKa	256	1	180	0.0710	0.0004	104	0.00060	0.00001	0.00063
AMD_EPYC_7763_64-Core_Processor	Milan	CaltechLIGO	128	1	7	0.1501	0.0002	6	0.00136	0.00000	0.00134
AMD_EPYC_7H12_64-Core_Processor	Rome	Nikhef	64	1	20	0.1236	0.0001	20	0.00118	0.00000	0.00110
Intel(R)_Xeon(R)_CPU_E5-2650_v4_@_2.20GHz	Broadwell	CERN	24	1	13	0.0990	0.0003	8	0.00092	0.00000	0.00088
Intel(R)_Xeon(R)_CPU_E5-2665_0_@_2.40GHz	SandyBridgeEP	GridKa	32	1	12	0.0410	0.0001	12	0.00028	0.00000	0.00036
Intel(R)_Xeon(R)_CPU_E5-2670_0_@_2.60GHz	SandyBridgeEP	GridKa	32	1	12	0.0497	0.0003	12	0.00035	0.00000	0.00044
Intel(R)_Xeon(R)_CPU_E5-2680_v3_@_2.50GHz	Haswell	Nikhef	24	1	20	0.1076	0.0002	20	0.00094	0.00000	0.00096
Intel(R)_Xeon(R)_Gold_5218_CPU_@_2.30GHz	CascadeLake	CERN	32	1	13	0.1118	0.0002	8	0.00112	0.00000	0.00100
Intel(R)_Xeon(R)_Gold_6148_CPU_@_2.40GHz	Skylake	Nikhef	40	1	20	0.1178	0.0002	20	0.00117	0.00000	0.00105
Intel(R)_Xeon(R)_Gold_6238R_CPU_@_2.20GHz	CascadeLake	IHEP	56	1	12	0.1100	0.0004	16	0.00111	0.00000	0.00098
Intel(R)_Xeon(R)_Gold_6248_CPU_@_2.50GHz	CascadeLake	IHEP	40	1	13	0.1160	0.0003	16	0.00118	0.00000	0.00103
Intel(R)_Xeon(R)_Gold_6258R_CPU_@_2.70GHz	CascadeLake	IHEP	56	1	13	0.1207	0.0002	16	0.00123	0.00000	0.00108
Intel(R)_Xeon(R)_Gold_6338_CPU_@_2.00GHz	IceLake	IHEP	64	1	13	0.1219	0.0002	16	0.00118	0.00000	0.00109
Intel(R)_Xeon(R)_Silver_4216_CPU_@_2.10GHz	CascadeLake	CERN	32	1	31	0.1083	0.0003	92	0.00106	0.00000	0.00096
Intel_Core_Processor_(Haswell,_no_TSX,_IBRS)	Haswell	NDGF-T1	24	1	10	0.1000	0.0003	10	0.00092	0.00000	0.00089
AMD_EPYC_7302_16-Core_Processor	Rome	CERN	64	2	18	0.1839	0.0007	229	0.00164	0.00001	0.00164
AMD_EPYC_7302_16-Core_Processor	Rome	CC-IN2P3	64	2	10	0.1965	0.0003	10	0.00160	0.00000	0.00175
AMD_EPYC_7313_16-Core_Processor	Milan	CaltechLIGO	64	2	10	0.2428	0.0003	10	0.00198	0.00001	0.00216
AMD_EPYC_7313_16-Core_Processor	Milan	CC-IN2P3	64	2	10	0.2092	0.0013	10	0.00185	0.00001	0.00186
AMD_EPYC_7351_16-Core_Processor	Naples	INFN-T1	64	2	10	0.1506	0.0007	10	0.00125	0.00000	0.00134
AMD_EPYC_7443_24-Core_Processor	Milan	CC-IN2P3	96	2	10	0.1966	0.0003	10	0.00172	0.00001	0.00175
AMD_EPYC_7452_32-Core_Processor	Rome	PIC	128	2	15	0.1481	0.0007	16	0.00129	0.00001	0.00132
AMD_EPYC_7453_28-Core_Processor	Milan	CC-IN2P3	112	2	10	0.1861	0.0008	10	0.00162	0.00001	0.00166
AMD_EPYC_74F3_24-Core_Processor	Milan	CaltechLIGO	48	2	10	0.2352	0.0007	10	0.00196	0.00001	0.00210
AMD_EPYC_7513_32-Core_Processor	Milan	CC-IN2P3	128	2	10	0.1742	0.0007	10	0.00152	0.00001	0.00155
AMD_EPYC_7551P_32-Core_Processor	Naples	Nikhef	64	2	20	0.1314	0.0005	19	0.00106	0.00000	0.00117
AMD_EPYC_7702_64-Core_Processor	Rome	IJCLAB	256	2	14	0.1364	0.0003	10	0.00119	0.00000	0.00121
AMD_EPYC_7702_64-Core_Processor	Rome	GridKa	256	2	24	0.1256	0.0004	20	0.00102	0.00000	0.00112
AMD_EPYC_7713_64-Core_Processor	Milan	GridKa-Tier3	256	2	8	0.1437	0.0002	8	0.00120	0.00000	0.00128
AMD_EPYC_7742_64-Core_Processor	Rome	GridKa	256	2	48	0.1453	0.0004	21	0.00117	0.00001	0.00130
Intel(R)_Xeon(R)_CPU_E5-2630_v3_@_2.40GHz	Haswell	CERN	32	2	459	0.1201	0.0006	67	0.00102	0.00001	0.00107
Intel(R)_Xeon(R)_CPU_E5-2630_v4_@_2.20GHz	Broadwell	GridKa	40	2	12	0.1194	0.0005	12	0.00107	0.00000	0.00106
Intel(R)_Xeon(R)_CPU_E5-2640_v3_@_2.60GHz	Haswell	PIC	32	2	16	0.1299	0.0004	16	0.00107	0.00000	0.00116
Intel(R)_Xeon(R)_CPU_E5-2650_v4_@_2.20GHz	Broadwell	CC-IN2P3	48	2	10	0.1223	0.0005	10	0.00108	0.00000	0.00109
Intel(R)_Xeon(R)_CPU_E5-2650_v4_@_2.20GHz	Broadwell	CERN	48	2	18	0.1200	0.0003	89	0.00108	0.00000	0.00107
Intel(R)_Xeon(R)_CPU_E5-2650_v4_@_2.20GHz	Broadwell	Nikhef	48	2	20	0.1228	0.0002	20	0.00105	0.00000	0.00109
Intel(R)_Xeon(R)_CPU_E5-2680_v2_@_2.80GHz	IvyBridgeEP	CC-IN2P3	40	2	10	0.1136	0.0004	10	0.00067	0.00000	0.00101
Intel(R)_Xeon(R)_CPU_E5-2680_v4_@_2.40GHz	Broadwell	PIC	56	2	16	0.1399	0.0006	16	0.00138	0.00003	0.00125
Intel(R)_Xeon(R)_CPU_E5-2680_v4_@_2.40GHz	Broadwell	CERN	56	2	492	0.1354	0.0005	78	0.00121	0.00001	0.00121
Intel(R)_Xeon(R)_CPU__E5520__@_2.27GHz	NehalemEP	CA-UVic-Cloud	16	2	67	0.0807	0.0006	56	0.00053	0.00002	0.00072
Intel(R)_Xeon(R)_CPU__E5630__@_2.53GHz	WestmereEP	GridKa	16	2	12	0.0896	0.0004	12	0.00054	0.00000	0.00080
Intel(R)_Xeon(R)_Gold_5218_CPU_@_2.30GHz	CascadeLake	CERN	64	2	196	0.1389	0.0006	37	0.00134	0.00002	0.00124
Intel(R)_Xeon(R)_Gold_5320_CPU_@_2.20GHz	IceLake	CC-IN2P3	104	2	10	0.1511	0.0003	10	0.00151	0.00000	0.00135
Intel(R)_Xeon(R)_Gold_6130_CPU_@_2.10GHz	Skylake	CERN	64	2	495	0.1281	0.0011	74	0.00128	0.00001	0.00114
Intel(R)_Xeon(R)_Gold_6252_CPU_@_2.10GHz	CascadeLake	BNL	96	2	10	0.1287	0.0006	10	0.00126	0.00000	0.00115
Intel(R)_Xeon(R)_Gold_6326_CPU_@_2.90GHz	IceLake	CC-IN2P3	64	2	10	0.1735	0.0008	10	0.00174	0.00000	0.00155
Intel(R)_Xeon(R)_Silver_4114_CPU_@_2.20GHz	Skylake	CC-IN2P3	40	2	9	0.1308	0.0003	10	0.00122	0.00000	0.00117
Intel(R)_Xeon(R)_Silver_4216_CPU_@_2.10GHz	CascadeLake	IJCLAB	64	2	33	0.1304	0.0014	33	0.00123	0.00001	0.00116
Intel(R)_Xeon(R)_Silver_4314_CPU_@_2.40GHz	IceLake	CC-IN2P3	64	2	10	0.1582	0.0005	10	0.00156	0.00000	0.00141
Intel(R)_Xeon(R)_Silver_4316_CPU_@_2.30GHz	IceLake	CC-IN2P3	80	2	10	0.1505	0.0004	10	0.00151	0.00000	0.00134

N measurements = 58
Mean deviation from fit = 0.080

Number in each category:	11	12	15	20	Sum = 58
Measurements in each X-category:	351	182	227	1915	Sum = 2675
Measurements in each Y-category:	270	246	403	590	Sum = 1509

We were provided more “older” CPU systems for the benchmark measurements

All CPUs (blue) vs Top5 CPUs (red)



Y-Axis is the:
Mean deviation in y-axis from the fit
(figure of merit)

Reduces the scatter for some workloads

Task Force Survey

Surveyed the TF for thoughts on how to select HEPScore

1. Support for a HEPScore benchmark based on LHC and other experimental workloads
2. HEPScore should reflect the relative CPU usage of the experiments and application
3. HEPScore should run in a timely manner 3-6 hours
4. HEPScore should be valid for ALL and Top5 CPU architectures
5. HEPScore should be valid for one or more LHC beam period
6. Interest in a “fast HEPscore” and a “CPU+GPU HEPScore”

CPU usage

WLCG CPU usage:

ATLAS	40%
CMS	30%
ALICE	15%
LHCb	15%

Some data from other experiments but not all sites report to WLCG
Other experiments < 5%

Run time

Workload	Running Time (m)	# of events * # of threads
Atlas_gen_sherpa	31	200 * 1
Atlas_reco_mt	69	100 * 4
Atlas_sim_mt	156	5 * 4
CMS_gen_sim	42	20 * 4
CMS_digi	31	50 * 4
CMS_reco	51	50 * 4
Belle2_gen_sim_reco	25	50 * 1
Alice_gen_sim_reco	194*	3 * 4
LHCb_gen_sim	104	5 * 1
Juno_gen_sim_reco	67	50 * 1
Gravitational Wave	138	1 * 4
Total	908 (15+ hours)	

Times for three runs on reference machine

* - Alice reco currently not included in benchmark score, due to technical problems with reco workload. Reco is ~ 50% of running time. Once issue is resolved, could run only reco to shorten workload length.

Summary

We have a good set of data on benchmarks and workloads

We believe we have enough data to identify a number of potential HEPScore candidates

We hope that the current experiment workloads are finalized and can be reliably used for some years

Next step is to study different combinations for a HEPScore benchmark

Many options but we have reduced them to some logical choices