

US site report

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USQCD resources

machine		architecture	node
BNL QCDCQ	1/2 rack	BG/Q	(total 8192 cores)
FNAL pi0	314 nodes	ivy bridge E5-2650v2	16 cores
FNAL pi0g	32 nodes	ivy bridge E5-2650v2	16 cores + 4 K40m
FNAL Bc	224 nodes	opteron 6320	32 cores
FNAL Ds	421 nodes	opteron 6128	32 cores
FNAL Dsg	76 nodes	Xeon E5630	8 cores + 2 Tesla M2050
Jlab 12s	276 nodes	sandy bridge	16 cores
Jlab 12m	16 nodes		16 cores + 4 Phi 5110P
Jlab 12k	42 nodes		16 cores + 4 K20m
Jlab 10q	224 nodes	westmere	8 cores
Jlab 11g/10g/9g	123 nodes		8 cores + 4 GPU
Jlab 9q	328 nodes	nehalem	8 cores

US resources

machine		architecture	node
ALCF "Mira"	48 racks	BG/Q	(total 786432 cores)
OLCF "Titan"	18688 nodes	Cray XK7, opteron 6274	16 cores + 1 K20X
TACC "Stampede"	6400 nodes	sandy bridge E5-2680	16 cores + 1 Phi (KNC)
NCSA "Blue Waters"	>22500 nodes >4200 nodes	Cray XE6, opteron 6276 Cray XK7, opteron 6276	16 cores 8 cores + 1 K20X
LSU "SuperMic"	380 nodes	ivy bridge-EP E5-2680	20 cores + 2 Phi 7120P

- ▶ 3 BG/Q racks at BNL for exclusive use by RBC
- ▶ USQCD INCITE grants: 180 M BG/Q core-hours at ALCF and 100 M XK7 core-hours at OLCF
- ▶ Individual science collaborations have access to Stampede, SuperMic and Blue Waters as well as other NSF founded facilities

Announced future US resources

machine	architecture	
ALCF "Theta"	Cray/Intel system with Phi (KNL) more than 2500 nodes, 8.5 PFLOPS	late 2016
ALCF "Aurora"	Cray/Intel system with Phi (KNH) 180 PFLOPS	late 2018
NERSC "Cori" (1)	Cray/Intel 1400 nodes with Haswell CPUs	late 2015
(2)	Cray/Intel 9300 nodes with Phi (KNL)	mid 2016
OLCF "summit"	IBM Power9 CPU with Nvidia Volta GPU and NVLink ~ 3400 nodes, 5 × performance of Titan	2017

MILC: Asqtad $N_f = 2 + 1$

- Publicly available on ILDG and at NERSC
- Ensemble DOI are issued (see talk J. Simone)

a [fm]	$L^3 \times T$	m_l/m_s	#lattices	a [fm]	$L^3 \times T$	m_l/m_s	#lattices	
0.12	$20^3 \times 64$	0.4/0.4	332	0.09	$28^3 \times 96$	0.031/0.031	500	
	$20^3 \times 64$	0.2/0.2	341		$28^3 \times 96$	0.0124/0.031	1996	
	$20^3 \times 64$	0.1/0.1	340		$28^3 \times 96$	0.0093/0.031	1138	
	$20^3 \times 64$	0.05/0.05	425		$28^3 \times 96$	0.0062/0.031	1946	
	$20^3 \times 64$	0.04/0.05	351		$32^3 \times 96$	0.00465/0.031	983	
	$20^3 \times 64$	0.03/0.05	564		$40^3 \times 96$	0.0031/0.031	1016	
	$20^3 \times 64$	0.02/0.05	1758		$64^3 \times 96$	0.00155/0.031	791	
	$20^3 \times 64$	0.01/0.05	2023		$28^3 \times 96$	0.0062/0.0186	985	
	$28^3 \times 64$	0.01/0.05	257		$40^3 \times 96$	0.0031/0.0186	781	
	$20^3 \times 64$	0.007/0.05	1852		$40^3 \times 96$	0.0031/0.0031	596	
	$24^3 \times 64$	0.005/0.05	1802		0.06	$48^3 \times 144$	0.0072/0.018	625
	$20^3 \times 64$	0.03/0.03	367			$48^3 \times 144$	0.0054/0.018	617
	$20^3 \times 64$	0.01/0.03	357			$48^3 \times 144$	0.0036/0.018	753
	$32^3 \times 64$	0.005/0.005	701			$56^3 \times 144$	0.0025/0.018	800
						$64^3 \times 144$	0.0018/0.018	826
			$64^3 \times 144$	0.0036/0.0108		601		
			0.045	$64^3 \times 192$	0.0028/0.014	861		

MILC: HISQ $N_f = 2 + 1 + 1$

- ▶ Strange and charm close to physical value
- ▶ Box sizes greater than 3.2 pion Compton wavelengths
- ▶ Three volumes for use in finite-volume studies with boxes 3.2, 4.3, and 5.4 pion Compton wavelength
- ▶ Once complete, lattices will be stored at NERSC and Fermilab
- ▶ Intended mark-up for ILDG
- ▶ Resources: ALCF BG/Q, Blue Waters

a [fm]	$L^3 \times T$	m_l/m_s	#lattices	
0.15	$16^3 \times 48$	1/5	1020	
	$24^3 \times 48$	1/10	1000	
	$32^3 \times 48$	1/27	1000	
0.12	$24^3 \times 64$	1/5	1040	
	$24^3 \times 64$	1/10	1020	
	$32^3 \times 64$	1/10	1000	
	$40^3 \times 64$	1/10	1028	
	$48^3 \times 64$	1/27	1000	
0.09	$32^3 \times 96$	1/5	1011	
	$48^3 \times 96$	1/10	1000	
	$64^3 \times 96$	1/27	1047	
0.06	$48^3 \times 144$	1/5	1016	
	$64^3 \times 144$	1/10	1246	
	$96^3 \times 192$	1/27	675	
0.042	$64^3 \times 192$	1/5	570	in progress
	$144^3 \times 288$	1/27	123	in progress
0.03	$96^3 \times 288$	1/5	0	proposed

Hadron Spectrum Collaboration: anisotropic clover $N_f = 2 + 1$

- ▶ $m_\pi \approx 230$ MeV, anisotropy $\xi \approx 3.5$ ($a_s \approx 0.125$ fm, $a_t \approx 0.035$ fm)
- ▶ $32^3 \times 256$: total: 11506 traj. (incl. thermalization) in two streams
Resource: OLCF and ALCF BG/P, LLNL BG/P, NERSC (Hopper)
Status: generation complete, analysis on-going
- ▶ $40^3 \times 256$: total: 6562 traj. (incl. thermalization) in five streams
Resource: OLCF JaguarPF and Titan (a few traj. on Blue Waters)
Last $O(3000)$ trajectories generated on Titan fully on GPUs using QDP-JIT+QUDA+Chroma

JLabQCD: isotropic clover $N_f = 2 + 1$

- ▶ Isotropic clover fermion action with one iteration stout-link smearing
- ▶ Tree-level tadpole-improved Symanzik gauge action
- ▶ Non-perturbatively tuned c_{SW}

$L^3 \times 64$	a [fm]	M_π [MeV]	#traj	
$32^3 \times 64$	0.085	~ 410	5138	to be extended later
$32^3 \times 64$	0.081	~ 300	2638	to be extended later
$48^3 \times 96$	0.079	~ 200	674	to be extended later
$64^3 \times 128$	0.085	~ 200	~ 2000	3 streams, 1000 usable, $\tau = \frac{1}{2}$
$64^3 \times 128$	0.078	~ 150	40	just started

- ▶ Currently ILDG mark-up not intended, available within USQCD; contact B. Joó, D. Richards
- ▶ Resources: NCSA BlueWaters, OLCF Titan

RBC-UKQCD: (M)DWF $N_f = 2 + 1$

- ▶ Archived at Columbia University (files are accessible via scp and globus)
- ▶ Existing ensembles will be marked-up/made publicly available on ILDG

$24^3 \times 64 \times 16$	$a \approx 0.11$ fm	DWF+I, $M_\pi = 340 - 670$ MeV
$32^3 \times 64 \times 16$	$a \approx 0.08$ fm	DWF+I, $M_\pi = 303 - 412$ MeV
$48^3 \times 96 \times 24$	$a \approx 0.11$ fm	MDWF+I, $M_\pi = 139$ MeV
$64^3 \times 128 \times 12$	$a \approx 0.08$ fm	MDWF+I, $M_\pi = 139$ MeV
$32^3 \times 64 \times 12$	$a \approx 0.06$ fm	DWF+I, $M_\pi = 371$ MeV
$32^3 \times 64 \times 32$	$a \approx 0.14$ fm	DWF+ID, $M_\pi = 172, 250$ MeV
$32^3 \times 64 \times 24$	$a \approx 0.20$ fm	DWF+ID, $M_\pi = 116$ MeV
$32^3 \times 64 \times 24$	$a \approx 0.10$ fm	DWF+ID, $M_\pi = 297$ MeV
$32^3 \times 64 \times 12$	$a \approx 0.14$ fm	GMDWF+I, $M_\pi = 141$ MeV

- ▶ Currently proposed/generated ensembles

$32^3 \times 64 \times 24$	$a \approx 0.18$ fm	MDWF+ID, physical M_π
$48^3 \times 96 \times 12$	$a \approx 0.07$ fm	DWF+I, $M_\pi \sim 300$ MeV

RBC-UKQCD: MDWF+WDED $N_f = 2 + 1 + 1$

- ▶ WDED: Wilson gauge action with dislocation enhancing determinant

$32^3 \times 64 \times 32$	$1/a = 3 \text{ GeV}$	$M_\pi \approx 135 \text{ MeV}$ (in production)
$32^3 \times 64 \times 12$	$1/a = 4 \text{ GeV}$	$M_\pi \sim 400 \text{ MeV}$ (planned)
$48^3 \times 96 \times 12$	$1/a = 4 \text{ GeV}$	$M_\pi \sim 400 \text{ MeV}$ (planned)
$80^2 \times 96 \times 192 \times 32$	$1/a = 3 \text{ GeV}$	$M_\pi \sim 135 \text{ MeV}$ (planned)
$128^3 \times 256 \times 12$	$1/a = 4 \text{ GeV}$	$M_\pi \sim 140 \text{ MeV}$ (future)

- ▶ Resources: ALCF BG/Q and BG/Qs at UoE and BNL

USBSM: SU(3) gauge group and $N_f = 8$ staggered

- ▶ Staggered fermions improved with one step nHyp link-smearing
- ▶ Adjoint plaquette action at $\beta_F = 5.0$ and $\beta_A = -\beta_F/4$
- ▶ Truncate at least 300 MDTU for thermalization
- ▶ Resource: ALCF BG/P, evolution now performed in FUEL (qhmc)

masses	$64^3 \times 128$	$48^3 \times 96$	$32^3 \times 64$	$24^3 \times 48$	$16^3 \times 32$
0.002	70				
0.003	185				
0.004	252	1 152			
0.006		1 170			
0.008		1 755	3 024		
0.010		2 250	6 792	3 012	
0.015			3 018	10 074	
0.020				10 074	3 000
0.030					3 000
0.040					3 000
0.050					3 000

LSD: $SU(3)$ gauge group and $N_f = 8$ staggered

- ▶ Staggered fermions improved with one step nHyp link-smearing
- ▶ Adjoint plaquette action at $\beta_F = 5.0$ and $\beta_A = -\beta_F/4$
- ▶ Truncate at least 300 MDTU for thermalization
- ▶ Resource: BG/Q at LLNL, evolution performed in FUEL (qhmc)
- ▶ Restricted access at present

$64^3 \times 128$	$m_l = 0.000125$	3k MDTU
$48^3 \times 96$	$m_l = 0.000222$	12k MDTU
$32^3 \times 64$	$m_l = 0.005$	22k MDTU
$32^3 \times 64$	$m_l = 0.0075$	25k MDTU
$24^3 \times 48$	$m_l = 0.0075$	10k MDTU
$24^3 \times 48$	$m_l = 0.00889$	25k MDTU

LSD: SU(3) gauge group with domain-wall fermions

- ▶ Iwasaki gauge action
- ▶ $L_s = 16$, $M_5 = 1.8$
- ▶ Ordered and/or disorderd starts
- ▶ Additional ensembles e.g. fixed m_f at different β
- ▶ $O(500)$ to $O(5000)$
- ▶ Resources BG/L and BG/Q at LLNL
- ▶ Restricted access at present

N_f	$\left(\frac{L}{a}\right)^3 \times \frac{T}{a}$	β	m_f
2	$24^3 \times 48$	2.7	[0.01:0.005:0.03]
	$32^3 \times 64$	2.7	[0.005:0.005:0.03]
6	$16^3 \times 32$	2.1	[0.01:0.005:0.045]
	$32^3 \times 64$	2.1	[0.005:0.005:0.03]
8	$16^3 \times 32$	1.95	[0.015:0.005:0.05]
	$32^3 \times 64$	1.95	[0.01:0.005:0.03]
10	$16^3 \times 32$	1.95	[0.01:0.005:0.06]
	$32^3 \times 64$	1.95	[0.005:0.005:0.03]