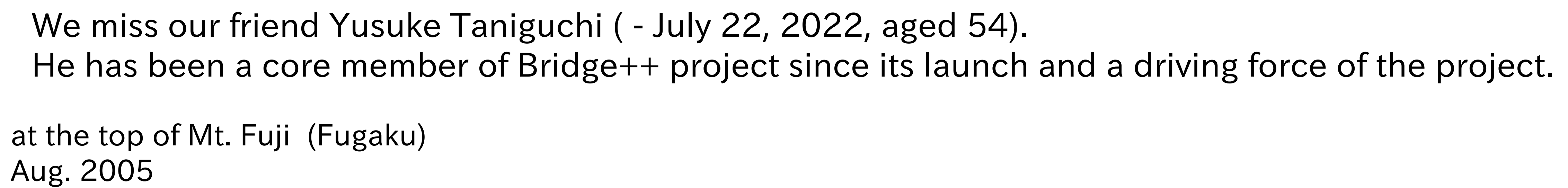


Lattice QCD code Bridge++
<http://bridge.kek.jp/Lattice-code/>



C++ object oriented framework
 Portable, easy to read, and extendable keeping reasonable performance
 Standard fermions, HMC, some measurements with test suite
 Version 1.0 release: 2009 new architectures have appeared since then

-SIMD version for AVX-512
I.K and H.Matsufuru, EPJ Web Conf 175 (2018) 09002; Lecture Notes in Computer Science, vol 10962 (2018) 456.

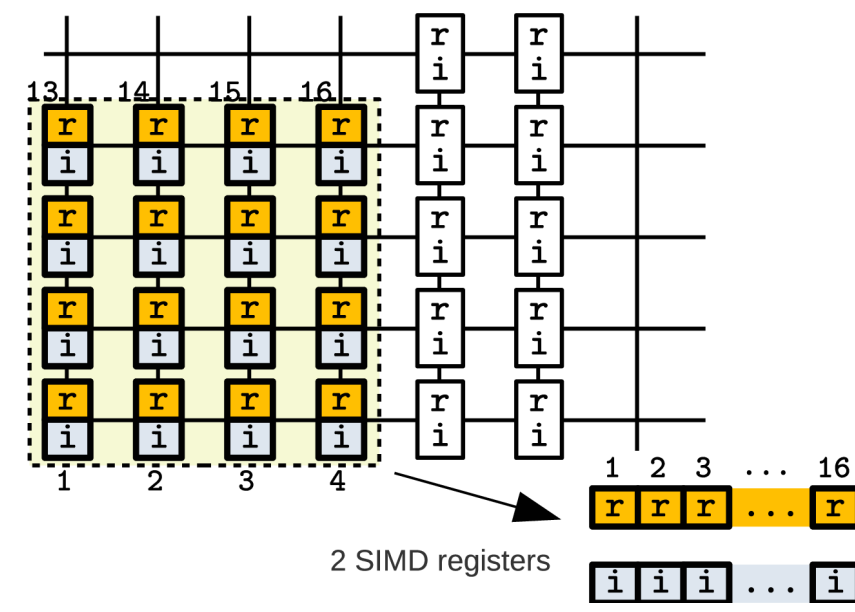
- GPU version with OpenACC
- yet another SIMD version for A64FX (Fugaku, etc.)

<https://www.r-ccs.riken.jp/en/fugaku/>

RIKEN Center for Computational Science (R-CCS), Kobe, Japan
the same place as K-computer
No. 2 of the Top 500
(No.1 in Jun.2020-Nov.2021)
Peak: 488 PFlops (2.0 GHz)
with 158,976 nodes
CPU: A64FX, 3,072 GFlops,
32GB HBM on chip
48+2(or 4) cores
Interconnect: TofuD



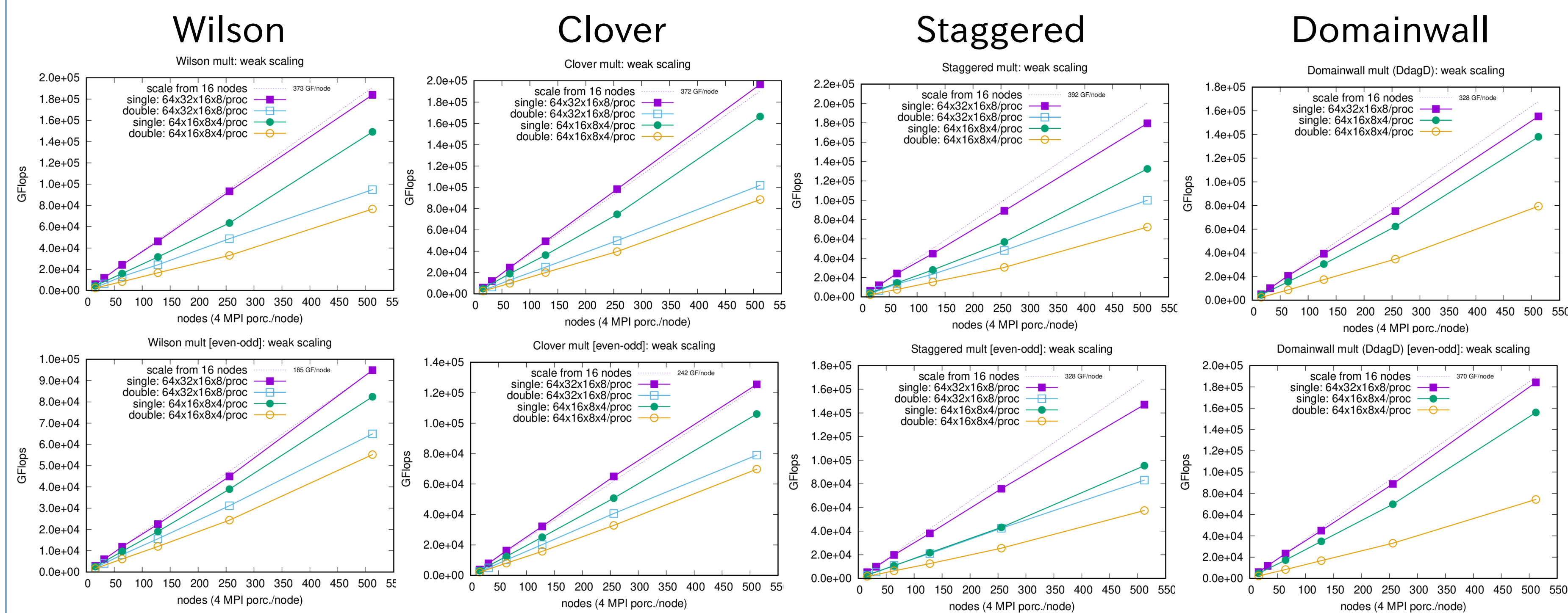
Re/Im parts are treated separately
2-dim site packing: 1x16, 2x8, 4x4, 8x2 [single prec.]
Use of Arm C-Language Extension (ACLE) [=intrinsics]
Scalable Vector Extension (SVE): 512 bits



Manual prefetch (partially)
MPI persistent communication + Fujitsu extension
(acceleration by the assistant cores)
Use of the special solver for Fugaku (QWS) as a part of MG solver

QCD Wide SIMD library (QWS) <https://github.com/RIKEN-LQCD/qws>

Weak scaling of Dirac Operator Multiplications



Clover

Clover BICG solver: weak scaling

scale from 16 nodes
 single: 64x32x16x8/proc
 double: 64x32x16x8/proc
 single: 64x16x8x4/proc
 double: 64x16x8x4/proc

192 GFlops

Domainwall

Domainwall CG solve: weak scaling

scale from 16 nodes
 single: 64x16x8x4/proc
 double: 64x16x8x4/proc

192 GFlops

Clover BICGstab solve [even-odd]: weak scaling

scale from 16 nodes
 single: 64x32x16x8/proc
 double: 64x32x16x8/proc
 single: 64x16x8x4/proc
 double: 64x16x8x4/proc

161 GFlops

Domainwall CG solve [even-odd]: weak scaling

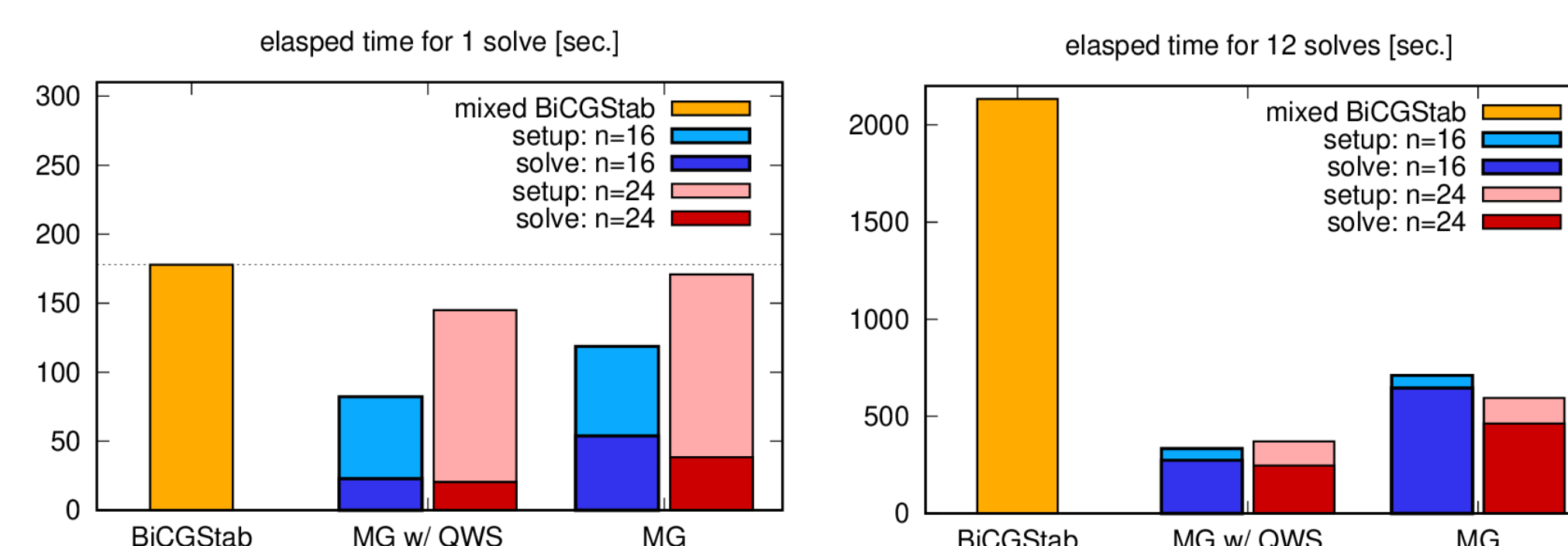
scale from 16 nodes
 single: 64x16x8x4/proc
 double: 64x16x8x4/proc

277 GFlops

SIMD tiling

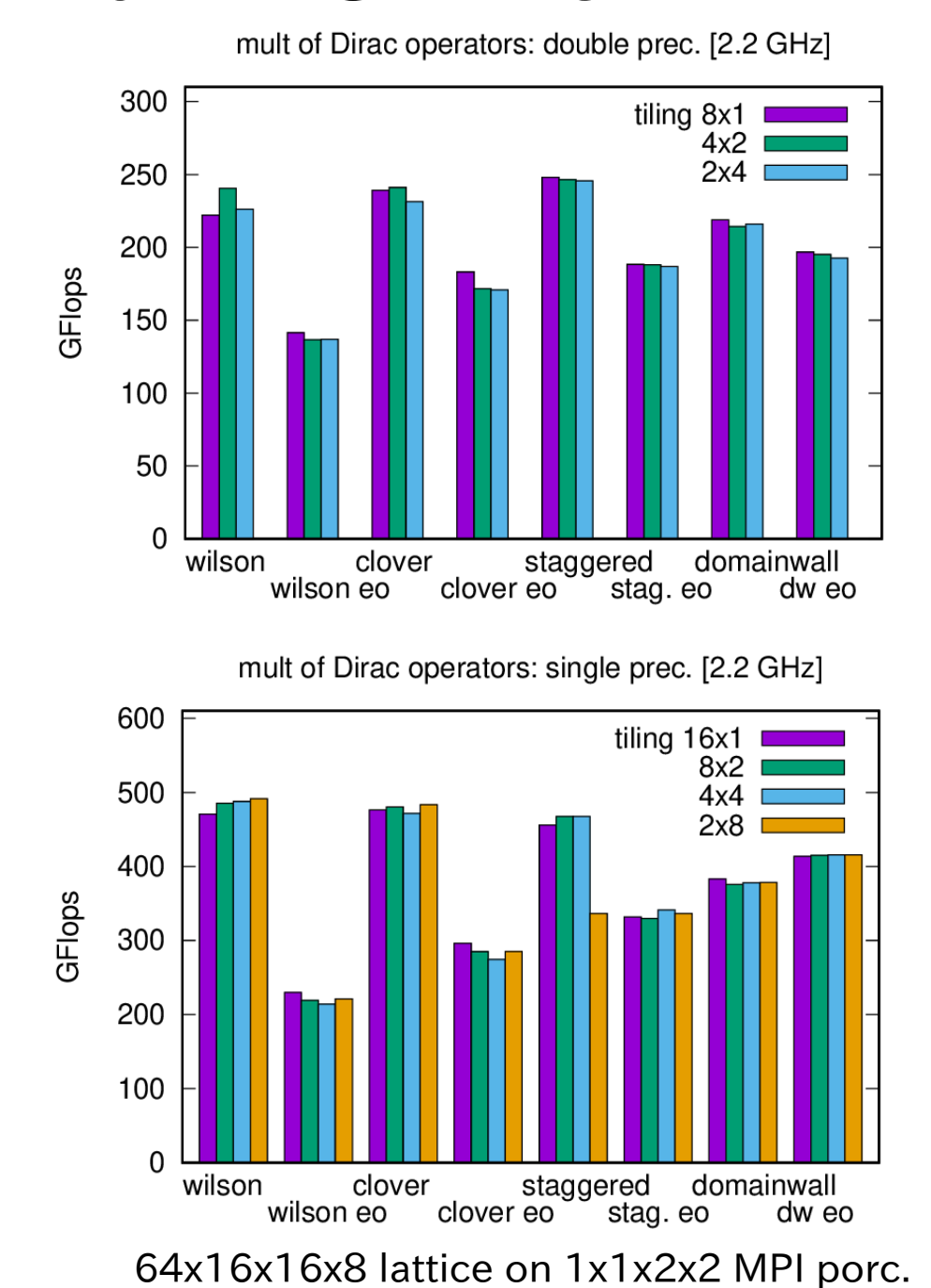
K-I. Ishikawa et al. PoS LATTICE2021(2022) 278

a variant of DD α AMG A. Frommer et al. , SIAM J. Sci. Comput. 36 (2014) A1581
smoother: multiplicative SAP, single prec. :from QWS
coarse solver: BiCGStab, single prec.
outer: FBiCGStab



96⁴ lattice, $M_\pi=145$ MeV configuration [PACS] on 216 nodes
cf. LDDHMC (reimplementation of QWS for HMC) : 52 sec/solve

1 node on 'flow' (Nagoya U)
A64FX @ 2.2 GHz



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