



Gauge Ensembles from PACS Collaboration

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Plan of Talk

- PACS Collaboration Members
- PACS Project w/ OFP and Fugaku
- Generation of “PACS10” Configs
 - Simulation Details
 - Physics w/ “PACS10” Configs
- Data Management and Publication Plan



PACS Collaboration Members

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PACS Project w/ OFP and Fugaku

Advantages of larger volume:

- Statistical fluctuation becomes smaller $\propto 1/\sqrt{V}$
- Accessible to small Q^2 region in investigating hadron form factors

⇒ Enlarge the volume $> (10 \text{ fm})^4$ at the physical point

PACS project started in 2016 at the same time of installation of OFP

OFP (Tsukuba-Tokyo): 25 PFlops

Shutdown in 2022.3

OFP-II (Tsukuba-Tokyo): Publically available in FY2023?



Fugaku (RIKEN): 540 PFlops

Public use started in 2021.3





Generation of “PACS10” Configs

PACS10 configs: 2+1 flavor QCD configs with physical vol. $> (10 \text{ fm})^4$

β	1.82	2.00	2.20
Lattice size	128^4	160^4	256^4
Lattice spacing	0.085 fm	0.064 fm	~ 0.043 fm
Physical vol.	$(10.9 \text{ fm})^4$	$(10.2 \text{ fm})^4$	$\sim (11 \text{ fm})^4$
Status	finished	finished	on going

- Carefully tuned to the physical point
- #Configs=20 \sim 40 depending on β
- Additional 64^4 lattice at $\beta = 1.82$ to check finite size effects
 $L \approx 5.5$ fm, $m_\pi L \approx 3.7$ (typical physical vol. used in the world)



Simulation Details

PACS,PRD99(2019)014504,PRD100(2019)034517

- Wilson-clover quark action + Iwasaki gauge action
 - Stout smearing with $\alpha=0.1$ and $N_{\text{smear}}=6$
 - Nonperturbative C_{SW} determined by SF
- Physical volume $> (10 \text{ fm})^4$
- Carefully tuned to the physical point (m_{π} , m_K , m_{Ξ})
- Simulation algorithm
 - Hasenbush-preconditioned DDHMC w/ active link for ud quarks,
 - RHMC for s quark
 - Multi-time scale integrator: $(N_0, N_1, N_2, N_3, N_4)$
 - trajectory length: $\tau \geq 1.0$
 - Chronological inverter guess
 - Solver: mixed precision nested BiCGStab



Physics w/ “PACS10” Configs

Major target is precision measurement and
physics beyond the standard model

- Hadron spectrum, PS meson decay constants
PRD100(2019)094502, PRD100(2019)094502
- Nucleon form factors (charge radius, g_A , tensor and scalar charges etc.)
PRD99(2019)014510, PRD102(2020)019902(E)
arXiv:2207.11914
- K_{l3} form factors (determination of $|V_{us}|$)
PRD101(2020)094504, arXiv:2206.08654
- HVP contribution to muon $g-2$
PRD100(2019)034517
- Proton decay matrix elements
PoS LATTICE2019(2020)141



Data Management and Publication Plan

Configs. are planned to be uploaded to ILDG in future

- When?

Under discussion within the collaboration

- Plan of DOI registration?

Yes

- Any conditions to use configs?

Should properly quote the specified references