NGT Algorithm Workshop

Lattice QCD at the large scale on exascale computing facilities

Jacob Finkenrath

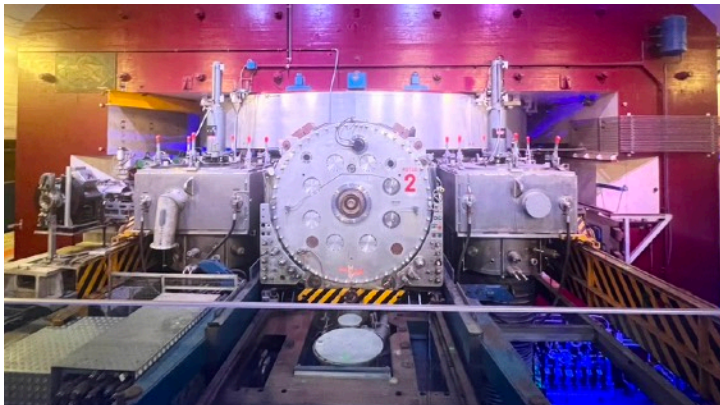**9. Dec 2024**

CERN | NexTGen
Next Generation Triggers

Outline

Next Generation Triggers

✦ Next Generation Triggers (NGT)

 https://nextgentriggers.web.cern.ch/

✦ Overview on the 1st Day of the NGT algorithm workshop

WHAT IS
NEXT GENERATION TRIGGERS?

Five years: 2024-2028 supported by an

external donation, combining

- ATLAS, CMS;
limited participation of ALICE, LHCb
- CERN's Theory & IT departments
- CERN's Exp Physics Software group

Project goals (proposal)

- opportunity for wider R&D
- improve LHC experiments in 2028+
- invest in community education and
training

In just a few microseconds, the complex triggers system can determine whether the information about a given collision event is worth keeping or not, but today we still discard the vast majority of raw data. Is it possible to do better?

THE NEXT GENERATION TRIGGERS

PROJECT IS BROKEN DOWN INTO **FOUR WORK PACKAGES:**

WP1
01
Infrastructure, Algorithms and Theory

WP2:
02
Enhancing the ATLAS Trigger and Data Acquisition

WP4:
04
Education Programmes and Outreach

WP3:
03
Rethinking the CMS Real Time Data Processing

NGT in TH

Task 1.4: Tensor Networks for Quantum Systems.
• *develop and apply quantum-inspired methodology*
Task 1.5: New computing strategies for data modeling and interpretation
• *development of software and algorithms for exploiting next-generation computer architectures*
Task 1.6: New Physics scenarios and Standard Model properties as trigger benchmarks
• *impact of the next-generation triggers on the enhanced sensitivity to New Physics scenarios*

WP 1: Connects different departments
• regular interconnection with IT, e.g. procurement of HPC cluster
• With the scope of being beyond CERN main R&D

NGT - Algorithm Workshop

Workshop will address main algorithmic challenges in LQCD:

Day 1: Signal to noise problem

- High precision in nucleon physics far away

Day 2: Continuum limit controlling via finer lattices

- Overcoming critical slowing down via generative models

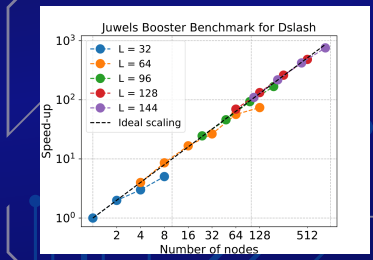**Day 3:** Utilisation of large scale machines

- Larger machines and larger lattices

- Main program will end on Wednesday around 13:00
- TH colloquium 14:00 - 15:30
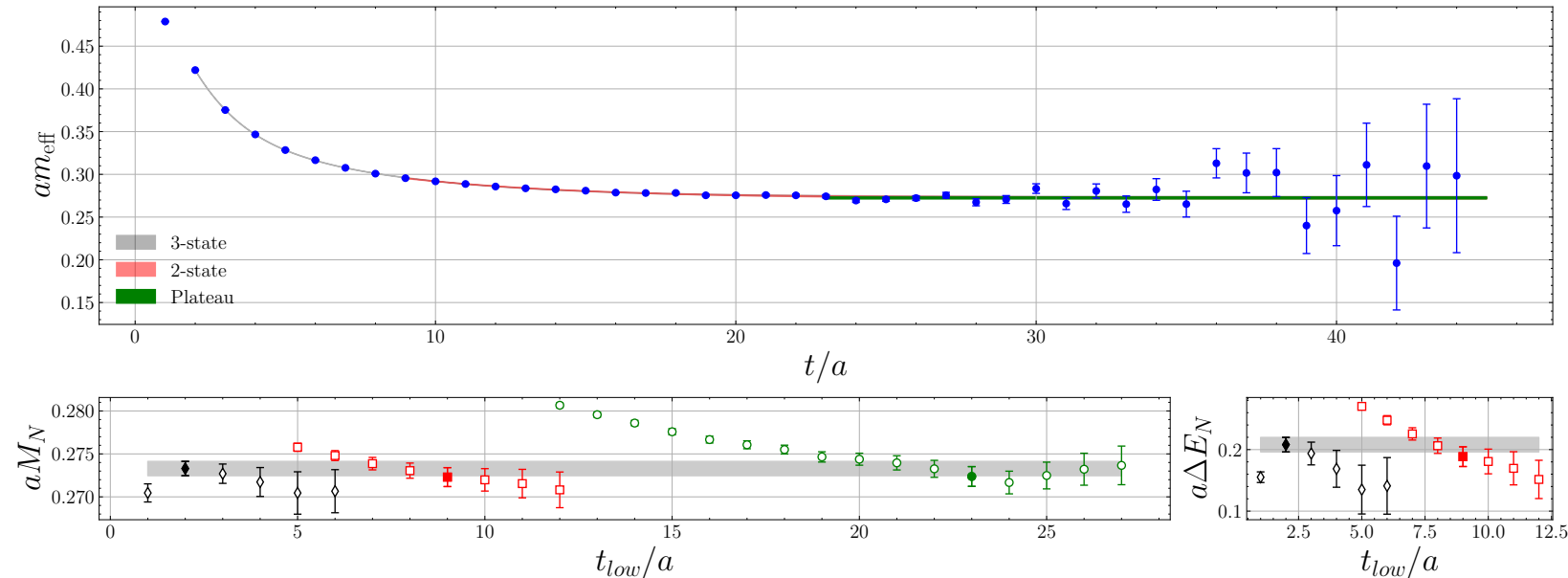- .. afterwards we will have time for discussions (15:30 - 17:00)

Day 1 - Challenges

Challenge:
Signal-to-noise:

- grows exponentially with time distance

- Excited state contamination, for short times correlator is not fully dominated by the ground state

C. Alexandrou, arXiv:2309.04401

Day 1 - Agenda

Morning Session

11:00		
	Introduction	*Jacob Friedrich Finkenrath*
	4/3-006 - TH Conference Room, CERN	11:00 - 11:10
	Spectral densities from the lattice	*Alessandro Lupo*
	4/3-006 - TH Conference Room, CERN	11:10 - 11:55
12:00	**Lanczos and signal-to-noise**	*Michael Wagman*
	4/3-006 - TH Conference Room, CERN	11:55 - 12:40

Day 1 - Agenda

Afternoon Session

14:00	**Multigrid low-mode averaging** — *Roman Gruber* *4/3-006 - TH Conference Room, CERN* — 14:00 - 14:45
15:00	**Variance reduction for the vector current correlator** — *Tim Harris* *4/3-006 - TH Conference Room, CERN* — 14:45 - 15:15
	Coffee Break *4/2-011 - TH common room, CERN* — 15:15 - 16:00
16:00	**Multi-level sampling** — *Lorenzo Barca* *4/3-006 - TH Conference Room, CERN* — 16:00 - 16:45
17:00	**Generative models at CERN** — *Dr Sofia Vallecorsa* *4/3-006 - TH Conference Room, CERN* — 16:45 - 17:30

Day 1 - Agenda

Reception:
18:00 - 20:00

• South wing of restaurant 1 (Building 501)

• Wing located towards Hostel or towards Défilé de l'Écluse

… restaurant is open until 22:00

NEXTGEN TRIGGERS ALGORITHM WORKSHOP

Lattice QCD at the large scale
on exascale computing facilities

Speakers:

Ryan Abbott (MIT), Simone Bacchio (Cyprus), Lorenzo Barca (DESY), Peter Boyle (BNL), Claudio Bonanno (Madrid), Timo Eichhorn (Wuppertal), Jacob Finkenrath (CERN), Roman Gruber (ETH), Tim Harris (ETH), Alessandro Lupo (Marseille), Sofia Vallecorsa (CERN), Michael Wagman (Fermilab), Evan Weinberg (Nvidia), Urs Wenger (Bern), Yukari Yamauchi (University of Washington)

Organisers:

Kate Clark, Matteo Di Carlo, Felix Erben, Jacob Finkenrath (chair), Andreas Jüttner, Bartosz Kostrzewa, Simon Kuberski, Stefan Roiser, Phiala Shanahan, J. Tobias Tsang

Juwels Booster Benchmark for Dslash
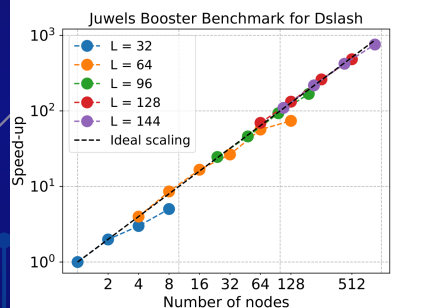
Day 1

Variance reduction; Long distance noise and excited states

Day 2

Novel sampling algorithms for fine lattice spacing; Fine lattice spacings and ML for physics

Day 3

Novel computing architectures; Scientific computing in the era of LLMs

9 - 11 December 2024

Location: 4/3-006 TH Conference Room, CERN

More information

CLICK HERE

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