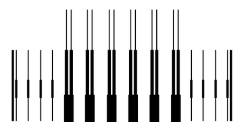


One Lab – Many Project Review of the WSCLAB



Gergely Gábor Barnaföldi
WSCLAB, HUN-REN Wigner Research Centre for Physics



MTA
Centre
of Excellence



ROLE>_

WSCLAB's origin

15 YEARS IN PARALLEL COMPUTING (WIGNER GPU LABORATORY) & HPC @ WDC

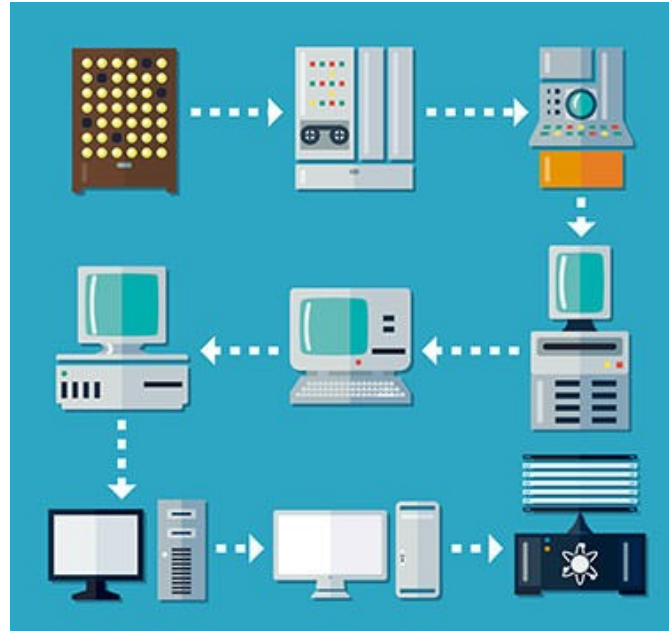


The aim of the Wigner GPU Laboratory is to provide support for any fields in science in sense of parallel computing techniques, especially for faster numerical calculations in gravitational and high-energy physics, astronomy, astrophysics, material sciences, and detector simulations. We have started with GPU technologies in 2009, but later our aim was improved to any kind of parallel computing technology. Today, many- and multi-core, GPU, FPGA, Xeon Phi technologies are all available in the laboratory. Beside the academic environment and other institutes, we have connections to industrial partners as well.



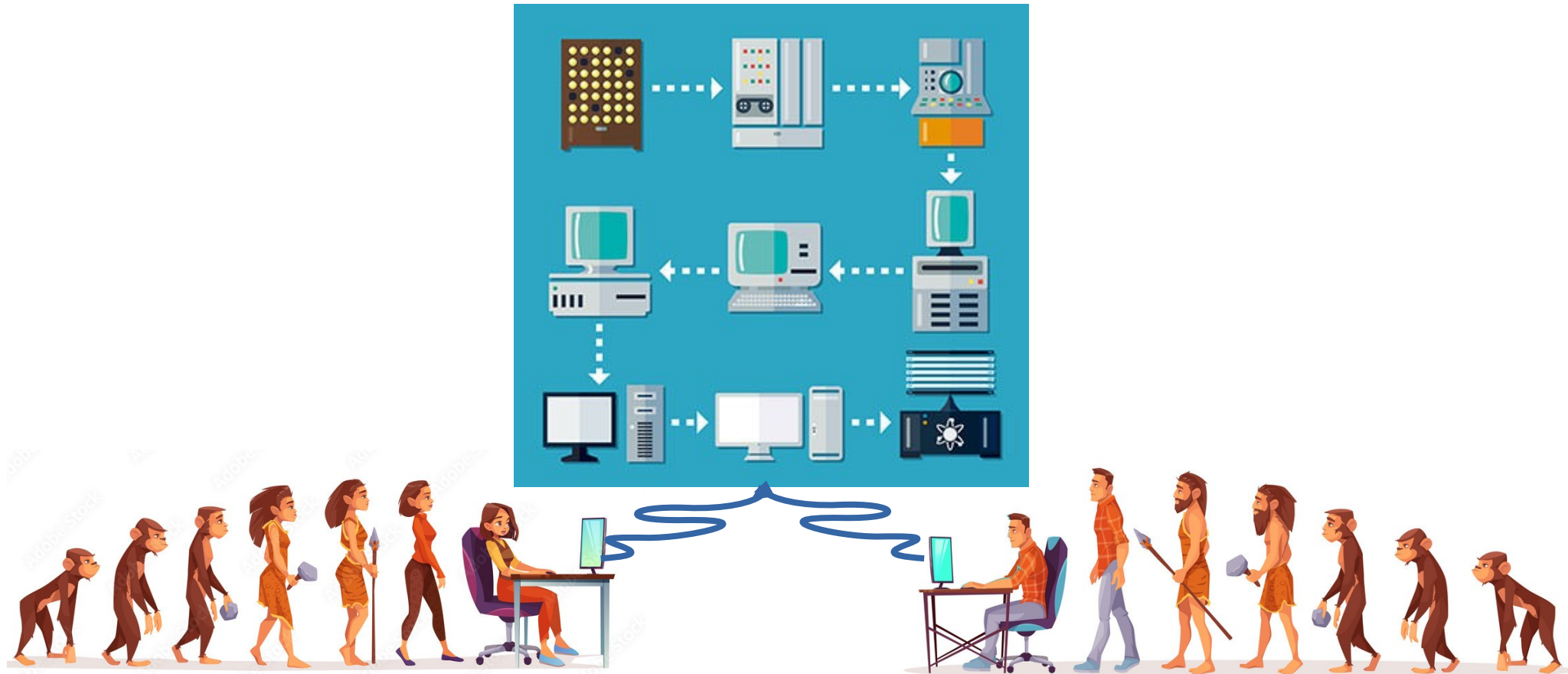
WSCLAB's role

15 YEARS IN PARALLEL COMPUTING (WIGNER GPU LABORATORY) & HPC @ WDC



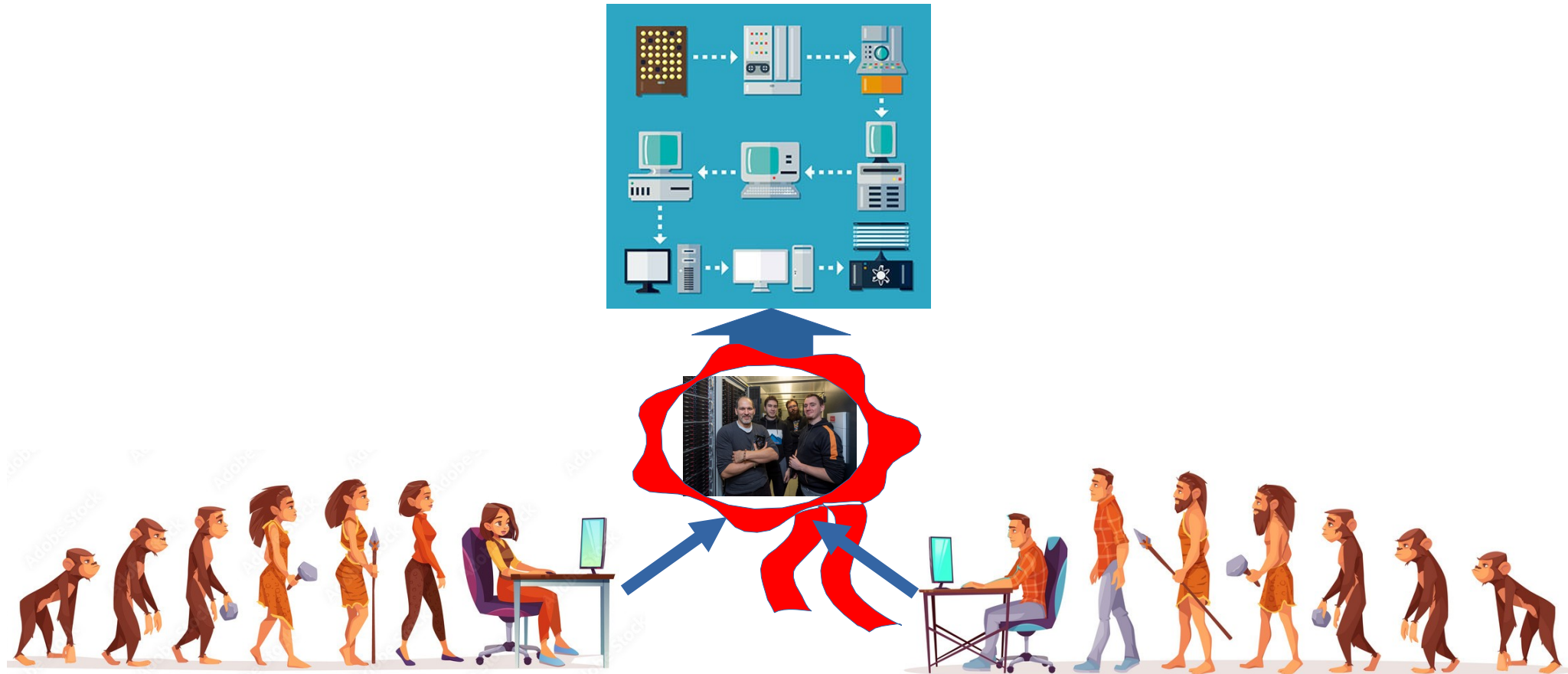
WSCLAB's role

15 YEARS IN PARALLEL COMPUTING (WIGNER GPU LABORATORY) & HPC @ WDC



WSCLAB's role

15 YEARS IN PARALLEL COMPUTING (WIGNER GPU LABORATORY) & HPC @ WDC



The History of WSCLAB's Wigner GPU Laboratory

- **2005-2008 Early years: idea of using GPU in HEP calculations**

Starting of the WLCG Grid (ALICE & CMS) Tier-2 at the Wigner

- 2009 Discussion with GGB & P. Lévai & G. Debrecezeni

2 main direction: HEP & Gravity

- **2010- 1st GPU Day & formation of the Wigner GPU Laboratory**

Students: M. F. Nagy-Egri & D. Berényi

- 2010- GPU Day series
- 2016- Lectures on Modern Computing in Science series
- 2016- Wigner GPU Lab Fellowship
- **2021- Wigner Scientific Computing Laboratory (NKFIH TOP50 RI)**



WSCLAB @ NKFIH TOP50 Research Infrastructure

START: 17TH DECEMBER 2021.

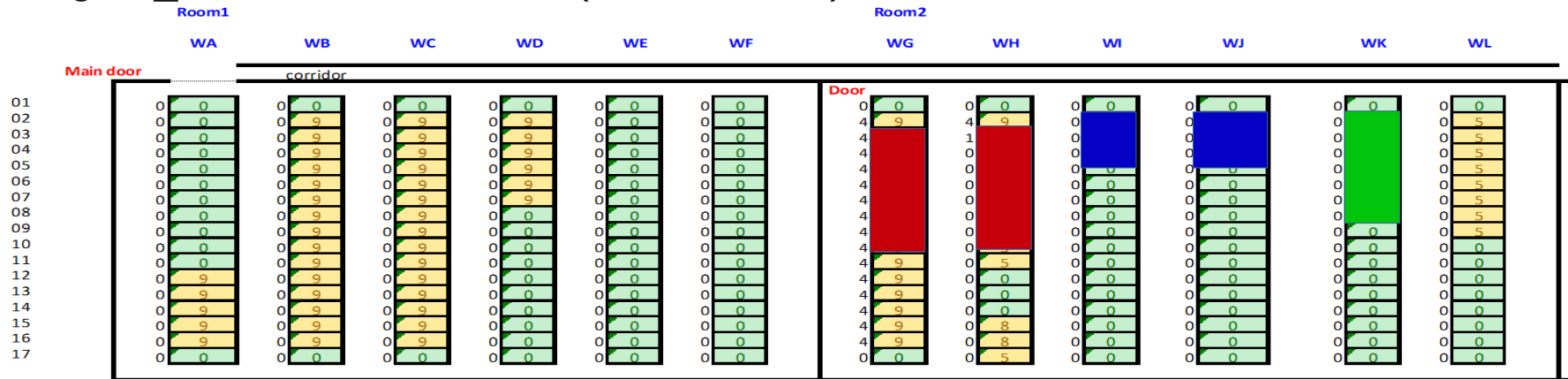


HARDWARES>_

WSCLAB @ WDC

THE PLACE

- ✓ Wigner Analysis Facility (Wigner AF)
- ✓ Wigner GPU Laboratory
- ✓ Wigner_KFKI WLCG T2 Grid (ALICE+CMS)



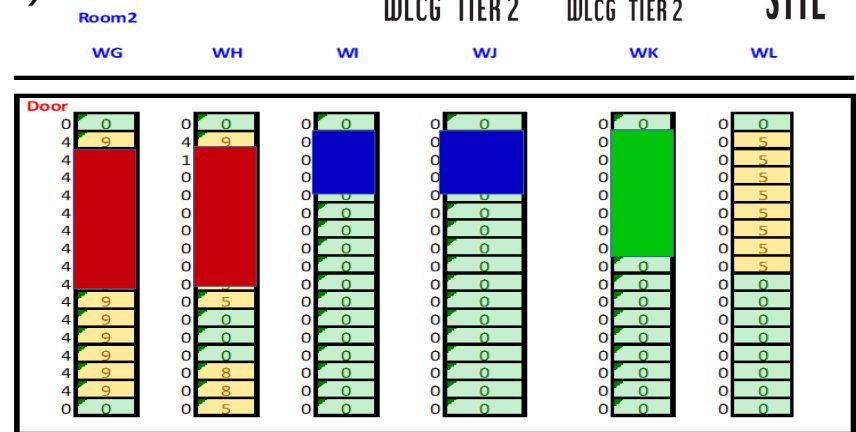
WSCLAB @ WDC

THE PLACE

- ✓ Wigner Analysis Facility (Wigner AF)
- ✓ Wigner GPU Laboratory
- ✓ Wigner_KFKI WLCG T2 Grid (ALICE+CMS)
- ✓ New: LIGO/VIRGO
- ✓ New: EuPRAXIA



SERVING LARGE-SCALE EU &
WORLDWIDE SCIENTIFIC
COMMUNITIES





EVENTS>_

GPU nap 2010

MTA KFKI Részecske- és Magfizikai Kutatóintézet
XII. Budapest, Konkoly-Thege Mikós út 29-33
2010 június 4.
(Előjelentkezés szükséges: <http://gpu.kfki.hu>)



Program kivonat:

- Ismerkedés a GPU programozással, gyakorlat
- Grafikus kártyák, mint asztali szuperszámítógépek
- Molekuladinamika számítások GPU-val
- Rács QCD és részecskefizikai alkalmazások
- GPU a kísérleti és elméleti gravitációkutatásban

[illegible][illegible][illegible]

The collage features a dark background with a circuit board pattern. A large, stylized text 'FUTURE OF MANY' is written diagonally across the top. Below it, the text 'CORE COMPUTING IN SCIENCE' is written in a similar style. In the bottom right, there is a photo of a person in a racing suit with the number 10. Various logos are scattered throughout, including Intel, Silicon Labs, AMD, and Solidangle. The text 'W9700' is visible in the bottom left corner.

**May 29
2014**

VENUE
 2014 Rensselaer Center
 Van Pelt Hall, 6th Floor
 650 Hudson Avenue
 Troy, NY 12180-2608
 Sessions: 9:00am-11:00am, 1:00pm-4:00pm

Web & Registration
www.w9700.org

PROGRAM
 9:00am-11:00am: Registration
 11:00am-12:00pm: Breakfast
 12:00pm-1:00pm: Lunch
 1:00pm-4:00pm: Sessions
 4:00pm-5:00pm: Reception
 5:00pm-6:00pm: Dinner
 6:00pm-7:00pm: Entertainment
 7:00pm-8:00pm: Entertainment
 8:00pm-9:00pm: Entertainment
 9:00pm-10:00pm: Entertainment
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The Future of Many-Core Computing in Science

2ND JUN **3RD JUN**

COMPUTING	MPG for Research and Education AMD: Rodent Open Compute SYNc Building Blocks Hardware - Not in FPGA Parallel Vector Expressions	AI	Volker Testa Habitat
PERFORMANCE	Computer Science Software Growth Performance Growth Hardware/Lang Generation	PERFORMANCE	Self-Driving Cars Line Segment Detection Depth Image Fusion
RESEARCH	Global Scientific Analysis Global Event Detection Efficient Image Generation Combinatorial Counting & Block Models	AI	CT Ring Artifact Removal Photomontage & CT Visualization ECG Processing & Visualization

REGISTER HERE: www.gpuday2016.com






A banner for GPU Day 2019. The background is a dark, abstract image featuring a grid of glowing blue and orange squares, resembling a circuit board or a data visualization. In the center, the text "GPU DAY 2019" is written in large, bold, white capital letters. Below it, the subtitle "The Future of Computing, Graphics and Data Analysis" is written in a smaller, white font. At the bottom, the dates "11-12 07 2019" are displayed in large, bold, white capital letters. On the left and right sides of the banner, there are two stylized logos: a blue square with a white diamond shape inside, and an orange square with a white diamond shape inside.The logo features a stylized green 'W' and 'G' intertwined, with the word 'WIGNER' in a bold, sans-serif font to the right. The background of the entire poster is a dark green grid pattern.

WIGNER GPU LABORATORY PRESENTS
GPU DAY 2021
10-11. NOVEMBER
MORE INFORMATION AND REGISTRATION:
[HTTPS://GPUDAY.COM/](https://gpuday.com/)
[HTTPS://INDICO.KFK.HU/EVENT/1330/](https://indico.kfk.hu/event/1330/)
KEYNOTE SPEAKERS: ALBERTO DI MEGLIO, OSKAR MENCER
THE FUTURE OF MASSIVE PARALLEL AND QUANTUM COMPUTING

EMERGING ACCELERATOR PLATFORMS
IMAGE PROCESSING, COMPUTER VISION, AND RECONSTRUCTION
INDUSTRIAL APPLICATIONS
GRAPHICS, RENDERING, AND MEDIA SYNTHESIS
COMPUTING AND VISUALIZATION IN EDUCATION
QUANTUM COMPUTING SIMULATION
MACHINE LEARNING, NEURAL NETWORKS, FEATURE RECOGNITION
MANY-CORE COMPUTING IN PHYSICS AND OTHER FIELDS OF SCIENCE



WIGNER SCIENTIFIC COMPUTING LABORATORY
GPU DAY 2022
20-21. JUNE

More information and registration:
[HTTPS://GPU.DAY.COM/](https://gpu.day.com/)
[HTTPS://INDICO.KFKI.HU/EVENT/1393/](https://indico.kfki.hu/event/1393/)

THE FUTURE OF MASSIVE PARALLEL, AND QUANTUM COMPUTING

EMERGING ACCELERATION PLATFORMS
 IMAGE PROCESSING, COMPUTER VISION, AND RECONSTRUCTION
 INDUSTRIAL APPLICATIONS
 GRAPHICS, RENDERING, AND IMAGE SYNTHESIS
 COMPUTING AND VISUALIZATION IN EDUCATION
 QUANTUM COMPUTING SIMULATION
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 MANY-CORE COMPUTING IN PHYSICS AND OTHER FIELDS OF SCIENCE

Logos for Wigner Scientific Computing Laboratory, NVIDIA, AMD, Intel, and various research institutions are displayed at the bottom.



The poster features a dark blue background with a glowing blue network of nodes and lines, resembling a neural network or data flow diagram. The title "THE FUTURE OF MASSIVE PARALLEL AND QUANTUM COMPUTING" is at the top in white. The main title "WIGNER SCIENTIFIC COMPUTING LABORATORY GPU DAY 2023" is prominently displayed in the center. Below it, the date "15-16 MAY" is shown. The poster lists various topics and fields of study, including machine learning, neural networks, and quantum computing. At the bottom, there are logos for partner organizations like ELKH, IBM, and NVIDIA, along with a QR code and a website link.

THE FUTURE OF MASSIVE PARALLEL AND QUANTUM COMPUTING

EMERGING ACCELERATION PLATFORMS
 IMAGE PROCESSING, COMPUTER VISION, AND RECONSTRUCTION
 INDUSTRIAL APPLICATIONS
 GRAPHICS, RENDERING, AND IMAGE SYNTHESIS
 COMPUTING AND VISUALIZATION IN EDUCATION
 QUANTUM COMPUTING STRATEGY
 MACHINE LEARNING, NEURAL NETWORKS, FEATURE RECOGNITION
 MANY-CORE COMPUTING IN PHYSICS AND OTHER FIELDS OF SCIENCE

WIGNER SCIENTIFIC COMPUTING LABORATORY
 GPU DAY 2023
 15-16 MAY

MORE INFORMATION AND REGISTRATION:
[HTTPS://GUBAY.COM/](https://gpubay.com/)
[HTTPS://INDICO.KFKI.HU/EVENT/1482/](https://indico.kfki.hu/event/1482/)

ELKH
 IBM
 NVIDIA
 KFKI

THE FUTURE OF MASSIVE PARALLEL AND QUANTUM COMPUTING

EMERGING ACCELERATED PLATFORMS
HYBRID QUANTUM CLASSICAL ARCHITECTURES
RESTRUCTURING FOR
MODERN APPLICATIONS
GRAPHICS, RENDERING, AND MACHINE COGNITION
COMPUTING AND VISUALIZATION IN TELECOM
QUANTUM COMPUTING SIMULATION
MACHINE LEARNING, NEURAL NETWORKS, FEATURE RECOGNITION
MANY-CODE COMPUTING IN PHYSICS AND OTHER FIELDS OF SCIENCE

WIGNER SCIENTIFIC COMPUTING LABORATORY
GPU DAY 2024
30-31. MAY
MORE INFORMATION AND REGISTRATION:
[HTTPS://GPU.DAY.COM/](https://gpu.day.com/)
[HTTPS://INDICO.KJFK.HU/EVENT/1567/](https://indico.kjfk.hu/event/1567/)



15th GPU DAY

MASSIVE PARALLEL COMPUTING FOR SCIENCE AND INDUSTRIAL APPLICATION

HUN REN **wigner**

Keynote SPEAKERS:

MICHAEL DOSER	CERN QUANTUM TECHNOLOGY INITIATIVE
SOFIA VALLECORSA	CERN OPENLAB
ROLAND JAKAB	HUNGARIAN RESEARCH NETWORK
ISTVAN CSABAI	ELTE

VENUE: HUN-REN CENTRE (1054 BUDAPEST, ALKOTMANY U. 29)

DATE: 22-23. MAY 2025

Information And Registration:
[HTTPS://GPUDAY.COM](https://gpuday.com)
[HTTPS://INDICO.WIGNER.HU/E/GPUDAY2025](https://indico.wigner.hu/e/gpuday2025)

HUN-REN **HUN REN** **wigner** **ibm** **9999** **skyblocks**



THE FUTURE OF MASSIVE PARALLEL AND QUANTUM COMPUTING

EMERGING ACCELERATOR PLATFORMS

IMAGE PROCESSING, COMPUTER VISION, AND RECONSTRUCTION

INDUSTRIAL APPLICATIONS

GRAPHICS, RENDERING, AND IMAGE SYNTHESIS

COMPUTING AND VISUALIZATION IN EDUCATION

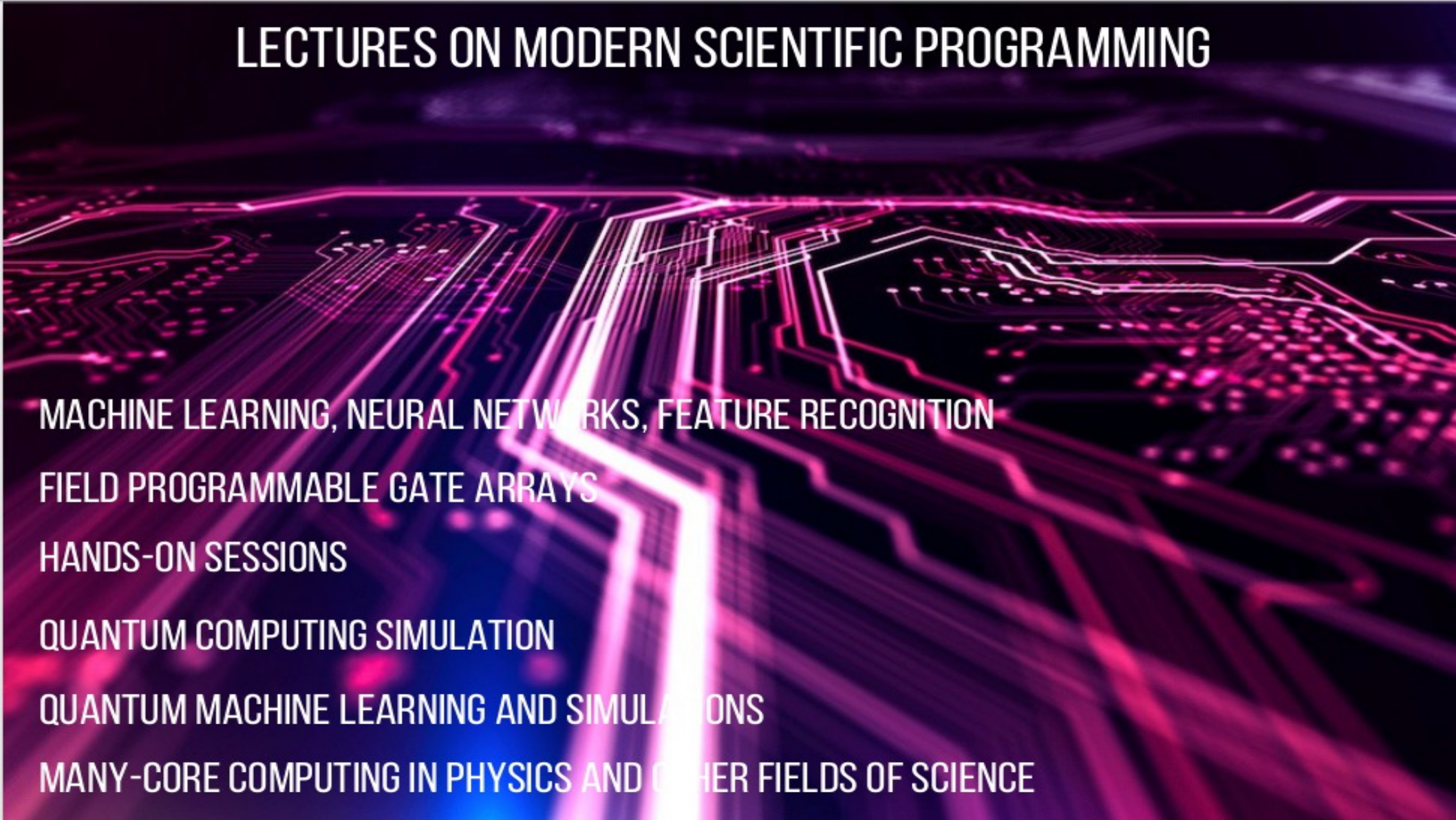
QUANTUM COMPUTING SIMULATION

MACHINE LEARNING, NEURAL NETWORKS, FEATURE RECOGNITION

MANY-CORE COMPUTING IN PHYSICS AND OTHER FIELDS OF SCIENCE



LECTURES ON MODERN SCIENTIFIC PROGRAMMING



MACHINE LEARNING, NEURAL NETWORKS, FEATURE RECOGNITION

FIELD PROGRAMMABLE GATE ARRAYS

HANDS-ON SESSIONS

QUANTUM COMPUTING SIMULATION

QUANTUM MACHINE LEARNING AND SIMULATIONS

MANY-CORE COMPUTING IN PHYSICS AND OTHER FIELDS OF SCIENCE

WSCLAB's EDUCATIONAL MATTERS

Why GitHub? Team Enterprise Explore Marketplace Pricing Search Sign In Sign up

wigner GPU Lab
Research group centered around massively parallel scientific calculations.
Budapest, Hungary <http://gpu.wigner.mta.hu/>

Repositories 6 Packages People Projects

OpenCL-Primer

Documentation on how to get started with OpenCL programming

BSD-3-Clause 0 0 0 Updated on Sep 26, 2019

SYCL-PRNG

A pseudo random number generator library written against the SYCL API.

C++ 1 4 1 0 Updated on Jun 11, 2019

Teaching

Material used for teaching.

C++ 8 43 1 (1 issue needs help) 0 Updated on Jun 7, 2019

HaladoAlkProg

Code samples for the "Haladó Alkalmazott Programozás" course

C++ MIT 0 0 0 Updated on May 15, 2019

LOMSP

Sample codes from the Lectures On Modern Scientific Programming series

C++ 1 1 0 0 Updated on Feb 14, 2018

SchwarzschildRaytracer

Raytracer in the Schwarzschild metric for visualization

C++ 1 0 0 0 Updated on Jun 2, 2017

wigner GPU Lab
54 subscribers

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Tovels Henriksen: Purely Functional GPU Programi... 7 views • 2 months ago

Michael Wong: The Future direction of SYCL and C++... 33 views • 2 months ago

István Kiss: Random Number Generation on GPUs 3 views • 2 months ago

GPU Day 2019: Opening the effects of data locality 5 views • 2 months ago

András Leiering: Modeling the effects of data locality 2 views • 2 months ago

Bálint Tereki: Optimal scheduling in a Multi GPU... 3 views • 2 months ago

Zoltán Juhász: High Performance Implementati... 4 views • 2 months ago

László Hajdú: GPU based real time trajectory... 4 views • 2 months ago

Zoltán Lohoczky: Tuning software into computer chl... 4 views • 2 months ago

Tibor Tóth: Head to the Exascale (2019.07.11) 4 views • 2 months ago

Gábor Varga: Supercomputing on demand 4 views • 2 months ago

Bálint Gyöngy: Enhanced Sequence Modeling with... 41 views • 1 year ago

Tamás Hegedüs: Characterizing the chloride... 9 views • 1 year ago



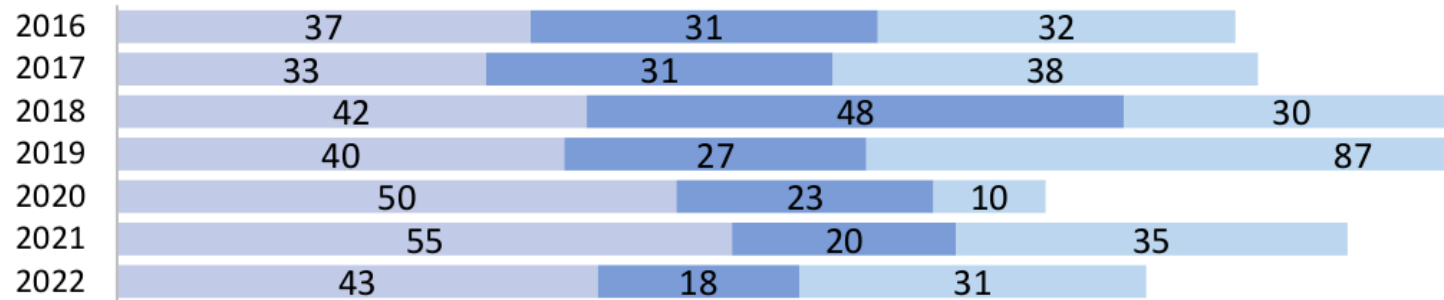
GitHub

PROJECTS>_

WSCLAB in numbers

KNOWLEDGE HUB: GPU DAY.COM

✓ 15 GPU Days



- ✓ 9 Lectures in Modern Computing in Science
- ✓ 65+ WSCLAB (Wigner GPU Lab) Fellowship
- ✓ 40+ industrial & academic partners (Lombiq LTD, Ericsson, 999999, Khronos, CERN...)
- ✓ 80+ scientific publications and program codes

WSCLAB's SCIENTIFIC RESULTS

BASED ON THE PROJECTS

✓ Finished Projects from various fields

- Astronomy & Astrophysics (18)
- Physics (34)
- Biochemistry (7)
- Life & Medical Sciences, Etology/Ornitology (8)
- Computational Sciences, Imaging, Simulations (16)
- Quantum Computing (11)



✓ List of Publications

- More than 80 publications & public codes





FUTURE>_

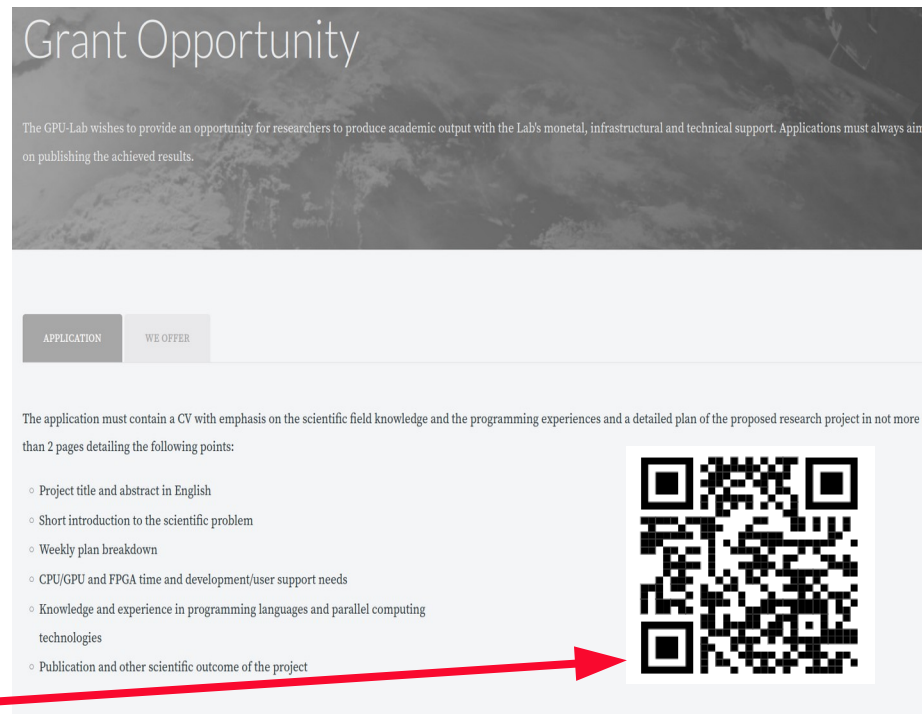
WSCLAB's FUTURE IS IN YOUR HAND

✓ What are the WSCLAB services

- Knowledge hub for scientific computing solutions
- Dedicated GPU & FPGA server hosting & services
- Quantum Computing simulations
- Tutorial series & teaching
- Advising highly-parallel computing
- PhD/PostDoc projects

✓ How to apply

- Visit wsclab.wigner.hu



The screenshot shows the 'Grant Opportunity' page on the WSCLAB website. The header features the title 'Grant Opportunity' in a large, white, serif font against a dark, textured background. Below the header, a paragraph states: 'The GPU-Lab wishes to provide an opportunity for researchers to produce academic output with the Lab's monetal, infrastructural and technical support. Applications must always aim on publishing the achieved results.' Below this text are two tabs: 'APPLICATION' (selected) and 'WE OFFER'. The 'APPLICATION' tab contains a paragraph: 'The application must contain a CV with emphasis on the scientific field knowledge and the programming experiences and a detailed plan of the proposed research project in not more than 2 pages detailing the following points:'. This is followed by a bulleted list of requirements: 'Project title and abstract in English', 'Short introduction to the scientific problem', 'Weekly plan breakdown', 'CPU/GPU and FPGA time and development/user support needs', 'Knowledge and experience in programming languages and parallel computing technologies', and 'Publication and other scientific outcome of the project'. To the right of the list is a large QR code. A red arrow points from the 'How to apply' section of the slide to the QR code.

Grant Opportunity

The GPU-Lab wishes to provide an opportunity for researchers to produce academic output with the Lab's monetal, infrastructural and technical support. Applications must always aim on publishing the achieved results.

APPLICATION WE OFFER

The application must contain a CV with emphasis on the scientific field knowledge and the programming experiences and a detailed plan of the proposed research project in not more than 2 pages detailing the following points:

- Project title and abstract in English
- Short introduction to the scientific problem
- Weekly plan breakdown
- CPU/GPU and FPGA time and development/user support needs
- Knowledge and experience in programming languages and parallel computing technologies
- Publication and other scientific outcome of the project



WSCLAB's FUTURE

PLANS FOR THE FUTURE

✓ Short timescale

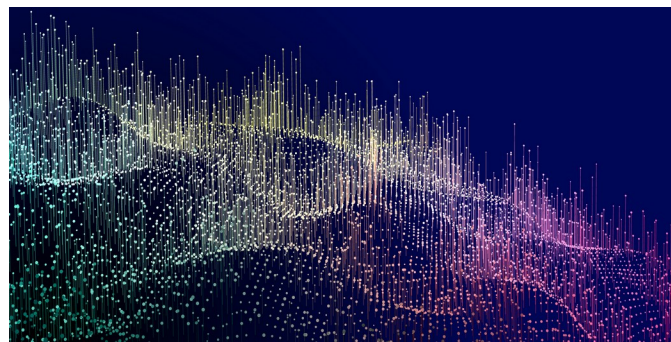
- New WSCLAB Grants for young scientists for 2024
- GPU Day 2025 series (22-23 May 2024)
- Lectures on Modern Computing in Science series (25112025) on QML

✓ Intermediate timescale

- Further local HW developments & cloud solutions

✓ Long range plan

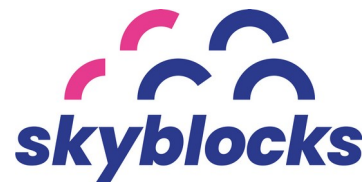
- Closely related to the EuroHPC LEVENTE project including Quantum Computing & Quantum simulations



HUN
REN



HUN-REN
Hungarian Research Network



STREAM
High Performance Computing



HPC@hu
Kompetencia Központ



Cerntech



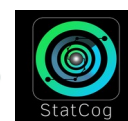
IN2P3
INSTITUT NATIONAL DE PHYSIQUE NUCLÉAIRE
ET DE PHYSIQUE DES PARTICULES



ELKH
Eötvös Loránd
Research Network



KRONOS
GROUP
CONNECTING SOFTWARE TO SILICON





Quantum Technology Initiative

CERN Quantum Technology Initiative launched in 2020

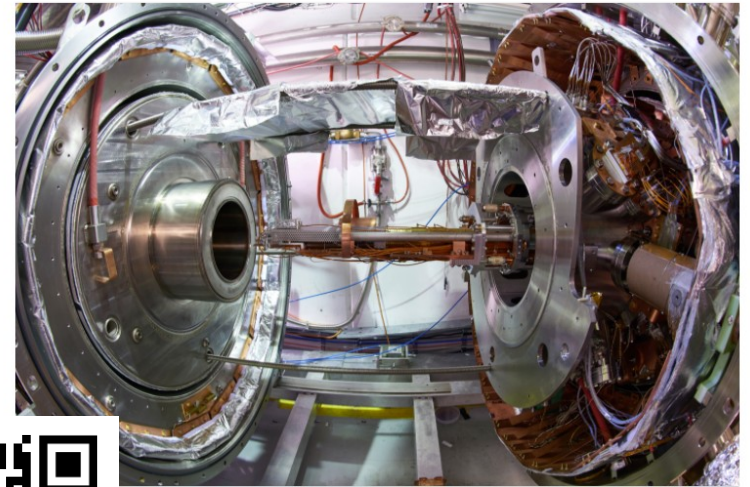
- **Quantum Technologies** can be revolutionary but require a **high level of expertise**
 - A **large number of initiatives** exists in the Member States and beyond
 - After an initial **exploratory phase** 2020-2023, Phase 2 started in 2024:
 - We are developing a **coherent research plan** that can evolve into a **long term strategy** aligned with CERN research program
- <https://quantum.cern>

Voir en [français](#)

CERN meets quantum technology

The CERN Quantum Technology Initiative will explore the potential of devices harnessing perplexing quantum phenomena such as entanglement to enrich and expand its challenging research programme

30 SEPTEMBER, 2020 | By Matthew Chalmers



ter trap stack. CERN's AEGIS experiment is able to explore the multi-particle entangled nature of photons from positronium
ye of several examples of existing CERN research with relevance to quantum technologies. (Image: CERN)



CERN QTI Phase 2

Launched January 2024

HYBRID QUANTUM
COMPUTING AND
ALGORITHMS

QUANTUM
NETWORKS AND
COMMUNICATIONS

CERN QUANTUM
TECHNOLOGY
PLATFORMS

COLLABORATION
FOR IMPACT



A 5 years research plan



CERN QTI Phase 2

Launched January 2024



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COLLABORATION
FOR IMPACT



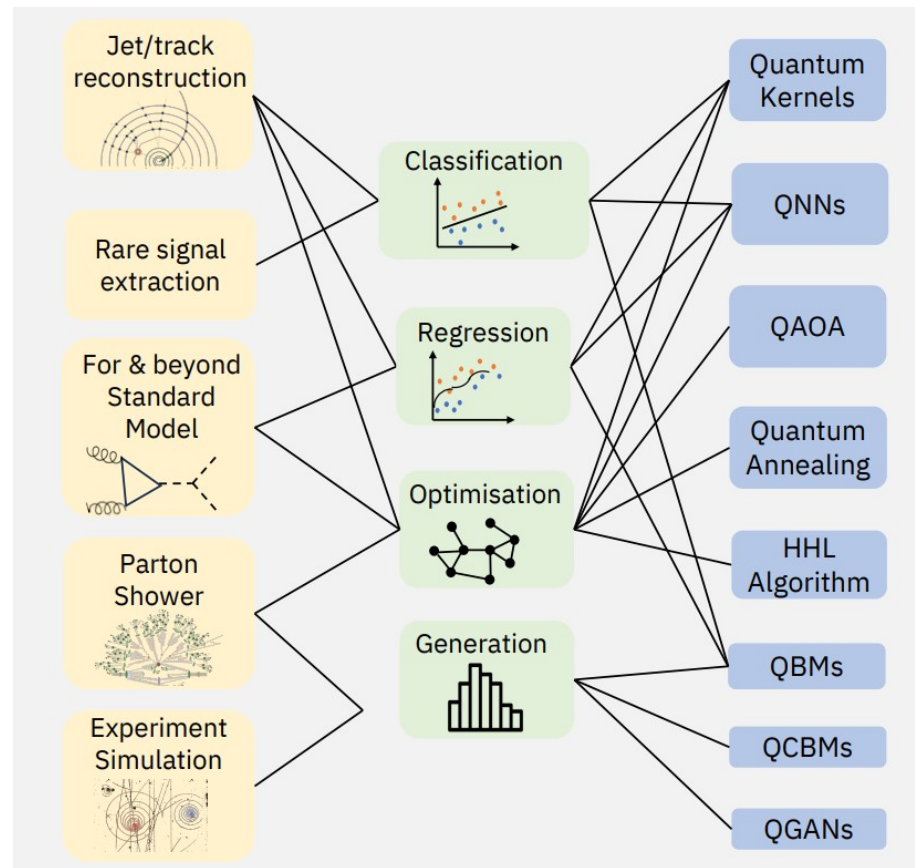
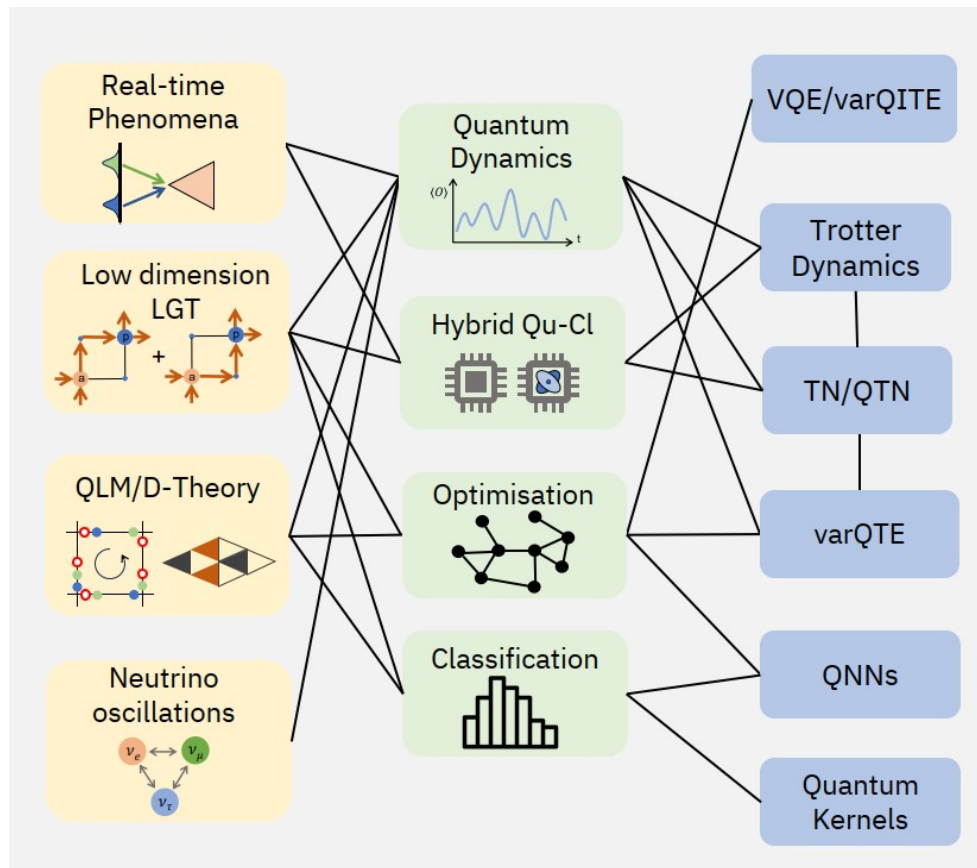
OPEN QUANTUM INSTITUTE



A 5 years research plan

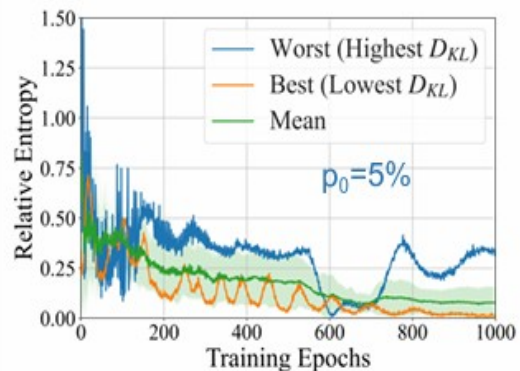


Quantum Computing

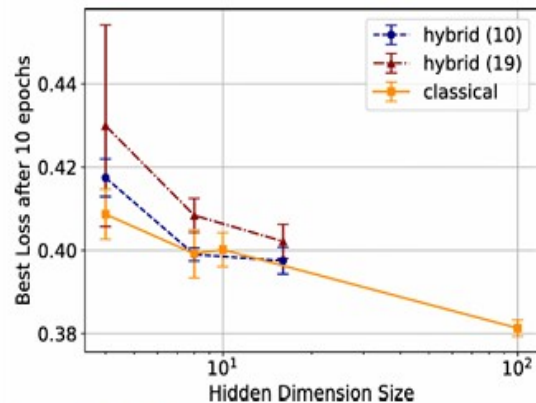


QC @CERN

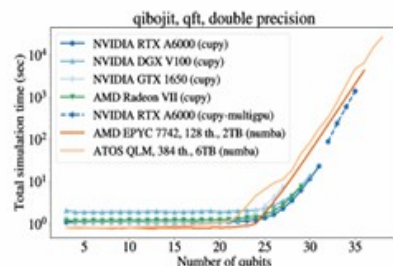
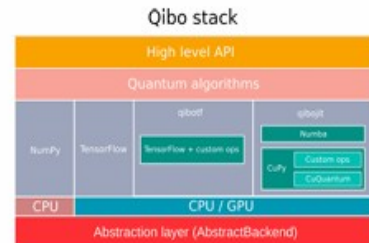
Borras, Kerstin, et al. "Impact of quantum noise on the training of quantum Generative Adversarial Networks." *arXiv preprint arXiv:2203.01007* (2022).



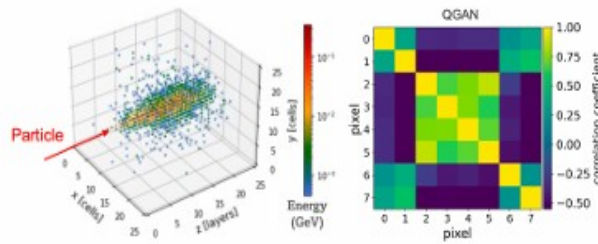
Tüysüz, Cenk, et al. "Hybrid quantum classical graph neural networks for particle track reconstruction." *Quantum Machine Intelligence* 3.2 (2021): 1-20.



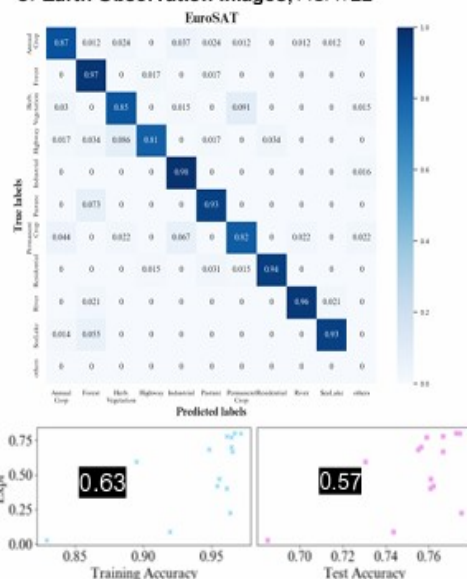
E.Stavros et al., Quantum simulation with just-in-time compilation, Quantum 2022



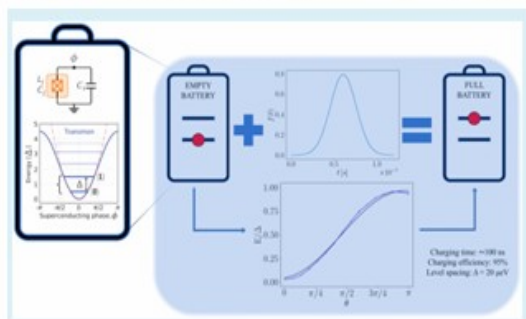
F.Rehm, Full Quantum GAN Model for HEP Detector Simulations, ACAT22



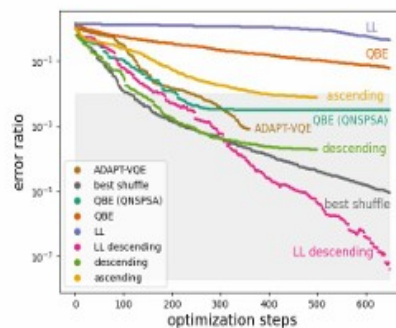
S.Chang, et al, Hybrid Quantum-Classical Networks for Reconstruction and Classification of Earth Observation Images, ACAT22



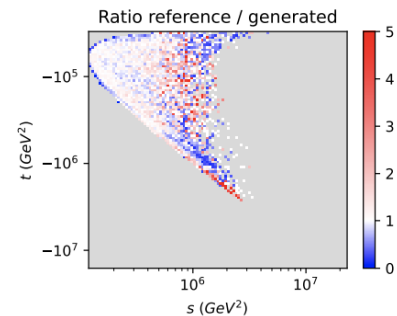
G. Gemme, M. Grossi et al, IBM Quantum Platforms: A Quantum Battery Perspective, Batteries 8, 43 (2022)



O. Kiss, Quantum computing of the 6Li nucleus via ordered unitary coupled cluster, 10.1103/PhysRevC.106.034325



Bravo-Prieto, Carlos, et al. "Style-based quantum generative adversarial networks for Monte Carlo events." *Quantum* 2022



Summary

- CERN Quantum Technologies Initiative
- Quantum sensing in High-energy Physics
- Some optics-related examples
- See more at CERN QTI's webpage

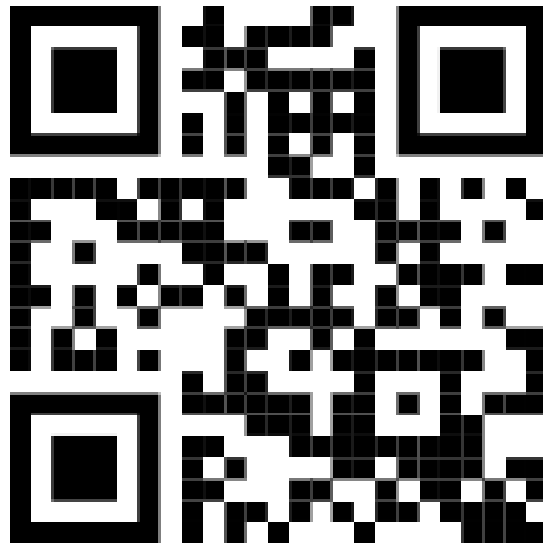


The screenshot shows the homepage of the CERN Quantum Technology Initiative. The header includes the CERN logo and navigation links: ABOUT, RESEARCH, COLLABORATION, EDUCATION, NEWS & EVENTS, RESOURCES, JOBS, and a search icon. The main banner features a large image of the CERN building at night with the text "CERN Quantum Technology Initiative" and "Accelerating Quantum Technology Research and Applications". Below the banner, there is a paragraph about the importance of quantum technology, followed by a paragraph about CERN's role as an "honest broker". A section titled "EVENTS" lists three upcoming events: "20 JAN/25 Quantum Technology for High Energy Physics Conference", "5 MAR/24 Operational launch of the Open Quantum Institute", and "19 NOV/23 QTML 2023". Each event entry includes a date, title, and a link to more information.

WSCLAB>_



WIGNER SCIENTIFIC COMPUTING LABORATORY





THX>_

