

WIGNER SCIENTIFIC COMPUTING LABORATORY

15TH GPU DAY

MASSIVE PARALLEL COMPUTING FOR SCIENCE AND INDUSTRIAL APPLICATION



HUN
REN | WIGNER

HUN-REN
Hungarian Research Network

**HUN
REN**

WIGNER



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

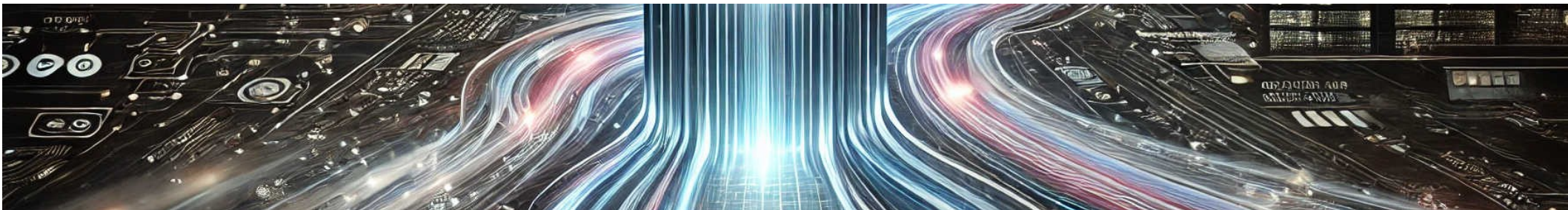
QUANTUM COMPUTING SIMULATION

MACHINE LEARNING, NEURAL NETWORKS, FEATURE RECOGNITION

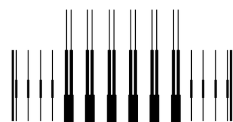
MANY-CORE COMPUTING IN PHYSICS AND OTHER FIELDS OF SCIENCE



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

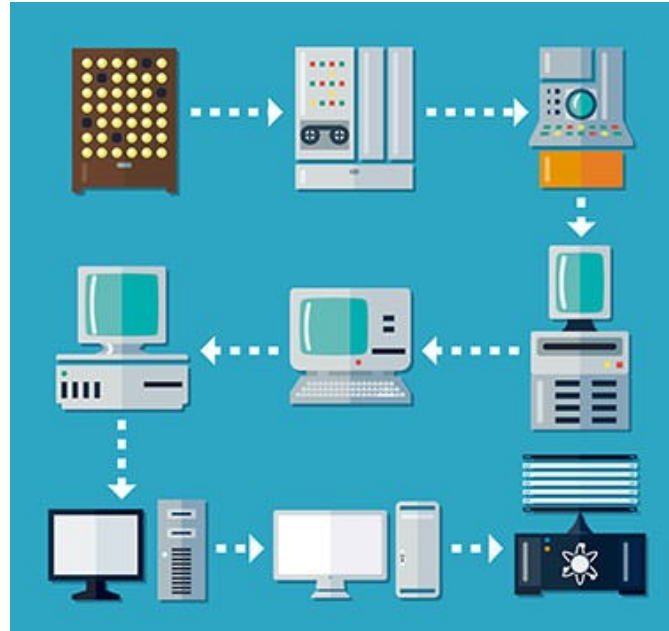


The aim of the Wigner GPU Laboratory is to provide support for any fields in science in sense of parallel computing techniques, especially for faster numerical calculations in gravitational and high-energy physics, astronomy, astrophysics, material sciences, and detector simulations. We have started 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.



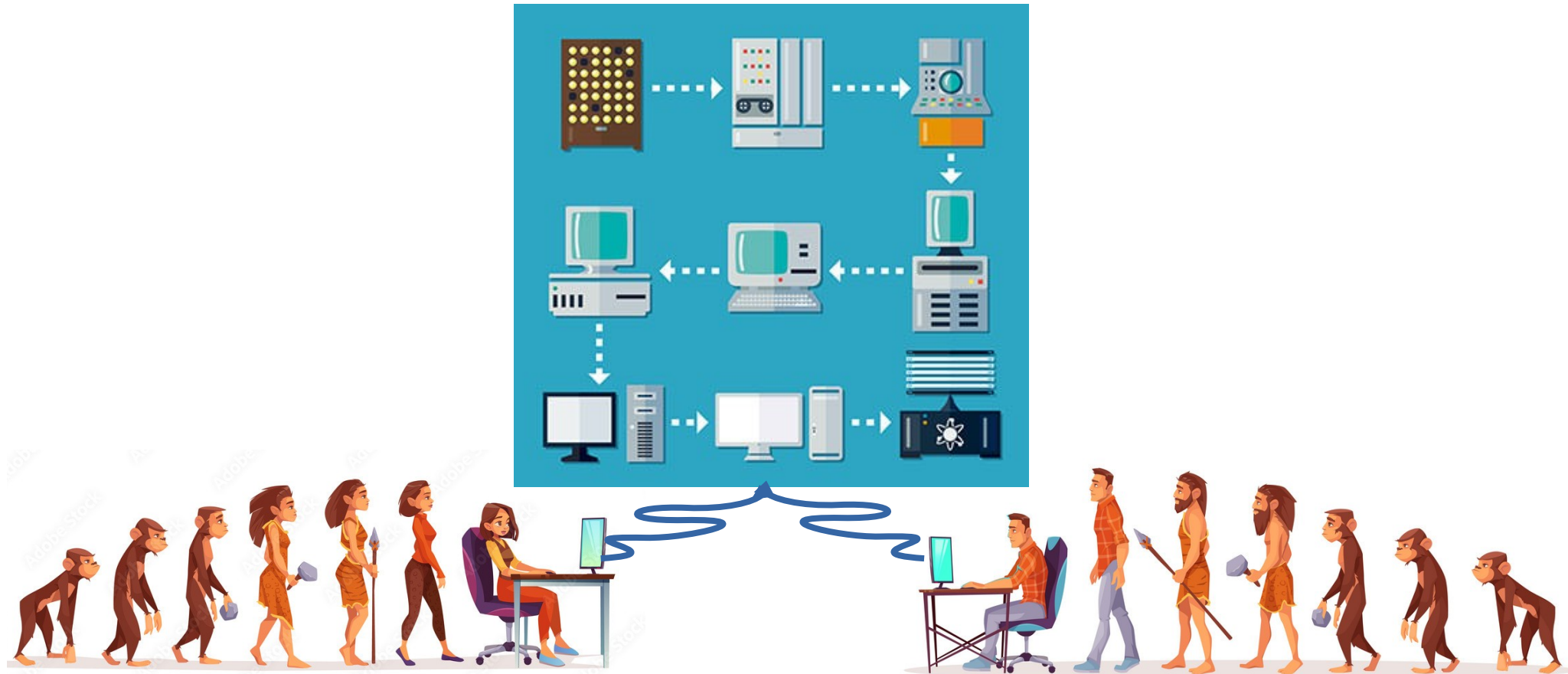
WSCLAB's role

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



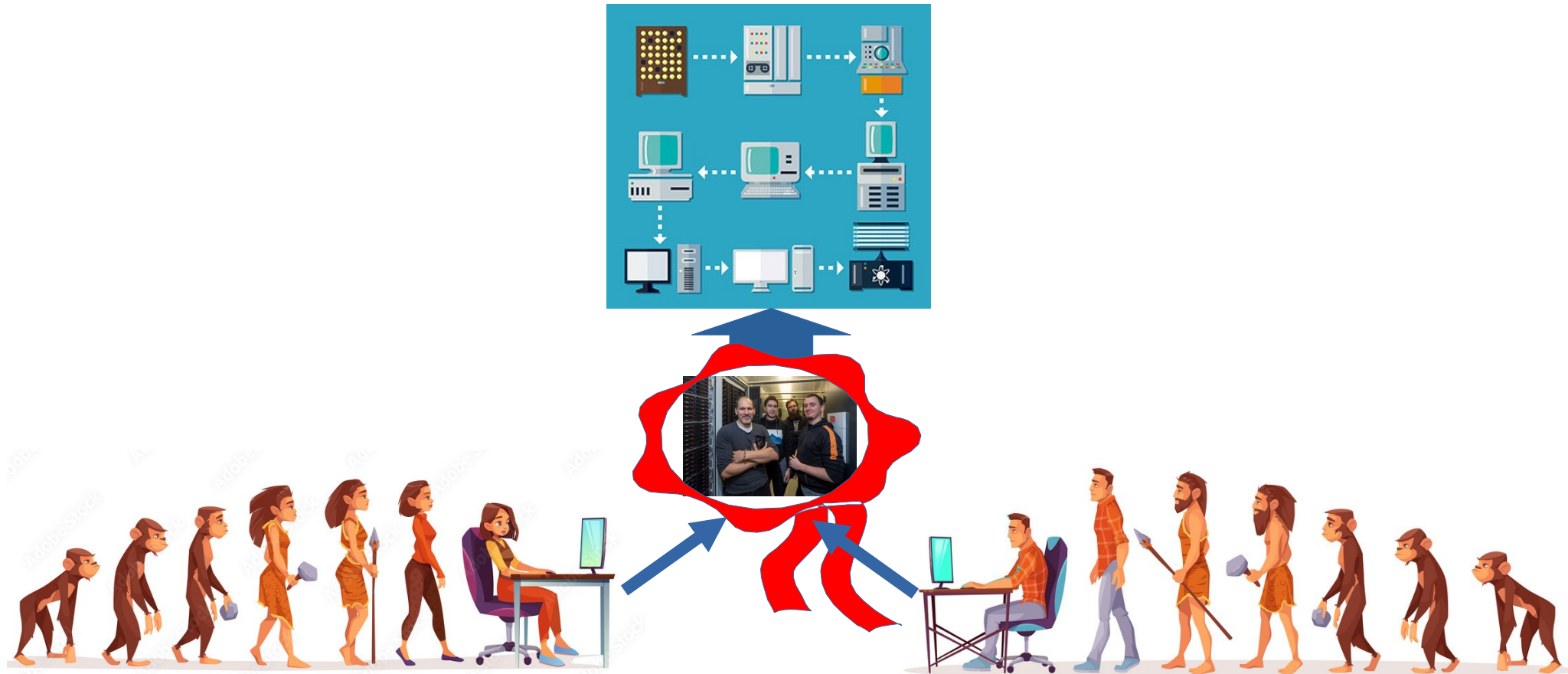
WSCLAB's role

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.



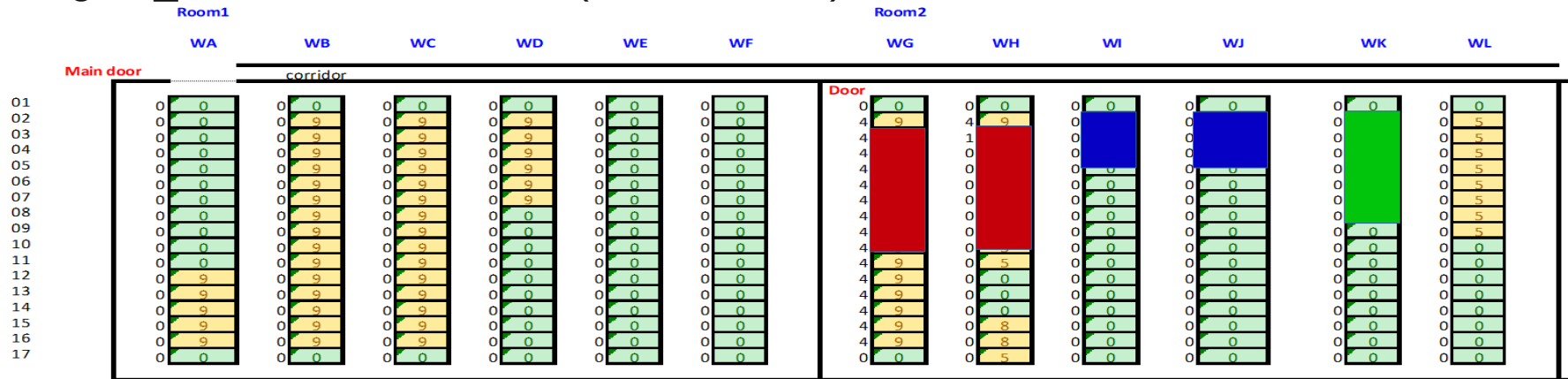
G.G. Barnafoldi: GPUday 2025

HARDWARES>_

WSCLAB @ WDC

THE PLACE

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



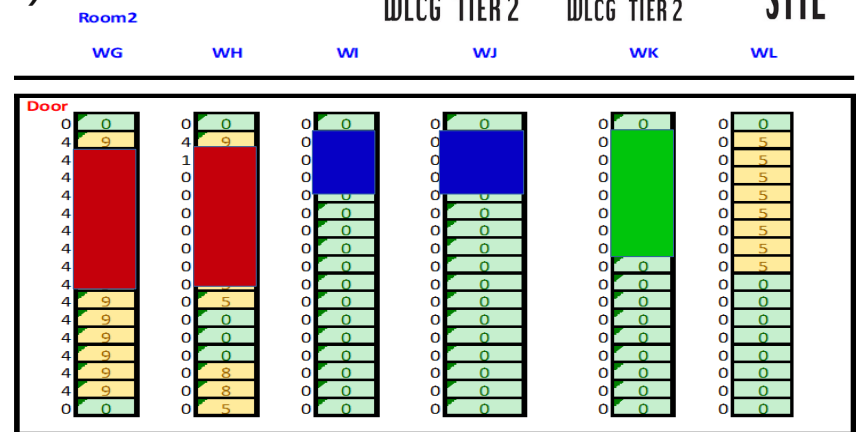
WSCLAB @ WDC

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 image is a collage of technology-related images. At the top, there's a circuit board. Below it, a person in a racing suit is shown. The background is a mix of blue and yellow. There are several logos: 'silicon' at the top right, 'AMD' in the middle right, and 'SOLIDANGLE' at the bottom right. The text 'FUTURE OF MANY' is written in large, bold, white letters across the top. The text 'CORE COMPUTING IN SCIENCE' is written in large, bold, white letters across the middle. The text 'Web & Registration' is written in white letters on the left. The text 'PROGRAM' is written in white letters on the left. The text 'W9700' is written in large, bold, white letters at the bottom left. The text 'W9700' is written in large, bold, white letters at the bottom left.

FUTURE OF MANY

CORE COMPUTING IN SCIENCE

Web & Registration

PROGRAM


W9700



silicon

AMD

SOLIDANGLE

W9700

TITLE	Conference		
GPU DAY 2015			
QUANTITY	The Future Of Many-Core Computing in Science		
ORGANIZER	 WIGNER GPU LABORATORY www.wignerlab.hu		Budapest, Hungary 2015-05-20-21 10:00-18:00
DATE	2015 May 20-21 WED-THU		
KEYNOTES	15:15 Reception 16:00 Lunch 16:30 Registration 17:00 Keynote 17:30 Keynote 18:00 Keynote 18:30 Keynote 19:00 Keynote 19:30 Keynote 20:00 Keynote 20:30 Keynote 21:00 Keynote 21:30 Keynote 22:00 Keynote 22:30 Keynote 23:00 Keynote 23:30 Keynote 00:00 Keynote 00:30 Keynote 01:00 Keynote 01:30 Keynote 02:00 Keynote 02:30 Keynote 03:00 Keynote 03:30 Keynote 04:00 Keynote 04:30 Keynote 05:00 Keynote 05:30 Keynote 06:00 Keynote 06:30 Keynote 07:00 Keynote 07:30 Keynote 08:00 Keynote 08:30 Keynote 09:00 Keynote 09:30 Keynote 10:00 Keynote 10:30 Keynote 11:00 Keynote 11:30 Keynote 12:00 Keynote 12:30 Keynote 13:00 Keynote 13:30 Keynote 14:00 Keynote 14:30 Keynote 15:00 Keynote 15:30 Keynote 16:00 Keynote 16:30 Keynote 17:00 Keynote 17:30 Keynote 18:00 Keynote 18:30 Keynote 19:00 Keynote 19:30 Keynote 20:00 Keynote 20:30 Keynote 21:00 Keynote 21:30 Keynote 22:00 Keynote 22:30 Keynote 23:00 Keynote 23:30 Keynote 00:00 Keynote 00:30 Keynote 01:00 Keynote 01:30 Keynote 02:00 Keynote 02:30 Keynote 03:00 Keynote 03:30 Keynote 04:00 Keynote 04:30 Keynote 05:00 Keynote 05:30 Keynote 06:00 Keynote 06:30 Keynote 07:00 Keynote 07:30 Keynote 08:00 Keynote 08:30 Keynote 09:00 Keynote 09:30 Keynote 10:00 Keynote 10:30 Keynote 11:00 Keynote 11:30 Keynote 12:00 Keynote 12:30 Keynote 13:00 Keynote 13:30 Keynote 14:00 Keynote 14:30 Keynote 15:00 Keynote 15:30 Keynote 16:00 Keynote 16:30 Keynote 17:00 Keynote 17:30 Keynote 18:00 Keynote 18:30 Keynote 19:00 Keynote 19:30 Keynote 20:00 Keynote 20:30 Keynote 21:00 Keynote 21:30 Keynote 22:00 Keynote 22:30 Keynote 23:00 Keynote 23:30 Keynote 00:00 Keynote 00:30 Keynote 01:00 Keynote 01:30 Keynote 02:00 Keynote 02:30 Keynote 03:00 Keynote 03:30 Keynote 04:00 Keynote 04:30 Keynote 05:00 Keynote 05:30 Keynote 06:00 Keynote 06:30 Keynote 07:00 Keynote 07:30 Keynote 08:00 Keynote 08:30 Keynote 09:00 Keynote 09:30 Keynote 10:00 Keynote 10:30 Keynote 11:00 Keynote 11:30 Keynote 12:00 Keynote 12:30 Keynote 13:00 Keynote 13:30 Keynote 14:00 Keynote 14:30 Keynote 15:00 Keynote 15:30 Keynote 16:00 Keynote 16:30 Keynote 17:00 Keynote 17:30 Keynote 18:00 Keynote 18:30 Keynote 19:00 Keynote 19:30 Keynote 20:00 Keynote 20:30 Keynote 21:00 Keynote 21:30 Keynote 22:00 Keynote 22:30 Keynote 23:00 Keynote 23:30 Keynote 00:00 Keynote 00:30 Keynote 01:00 Keynote 01:30 Keynote 02:00 Keynote 02:30 Keynote 03:00 Keynote 03:30 Keynote 04:00 Keynote 04:30 Keynote 05:00 Keynote 05:30 Keynote 06:00 Keynote 06:30 Keynote 07:00 Keynote 07:30 Keynote 08:00 Keynote 08:30 Keynote 09:00 Keynote 09:30 Keynote 10:00 Keynote 10:30 Keynote 11:00 Keynote 11:30 Keynote 12:00 Keynote 12:30 Keynote 13:00 Keynote 13:30 Keynote 14:00 Keynote 14:30 Keynote 15:00 Keynote 15:30 Keynote 16:00 Keynote 16:30 Keynote 17:00 Keynote 17:30 Keynote 18:00 Keynote 18:30 Keynote 19:00 Keynote 19:30 Keynote 20:00 Keynote 20:30 Keynote 21:00 Keynote 21:30 Keynote 22:00 Keynote 22:30 Keynote 23:00 Keynote 23:30 Keynote 00:00 Keynote 00:30 Keynote 01:00 Keynote 01:30 Keynote 02:00 Keynote 02:30 Keynote 03:00 Keynote 03:30 Keynote 04:00 Keynote 04:30 Keynote 05:00 Keynote 05:30 Keynote 06:00 Keynote 06:30 Keynote 07:00 Keynote 07:30 Keynote 08:00 Keynote 08:30 Keynote 09:00 Keynote 09:30 Keynote 10:00 Keynote 10:30 Keynote 11:00 Keynote 11:30 Keynote 12:00 Keynote 12:30 Keynote 13:00 Keynote 13:30 Keynote 14:00 Keynote 14:30 Keynote 15:00 Keynote 15:30 Keynote 16:00 Keynote 16:30 Keynote 17:00 Keynote 17:30 Keynote 18:00 Keynote 18:30 Keynote 		







The Future of Many-Core Computing in Science


2ND JUN **3RD JUN**

COMPUTING	<p>MPG for Research and Education AMD: Rodent Open Compute</p> <p>SYNc Building Blocks Hardware: Intel vs FPGA Parallel Vector Expressions</p>	AI	<p>Volker Roth: Fast Habitats</p>
PERFORMANCE	<p>Computer Architectures Software Growth Performance Growth Hardware/Level Generation</p>	PERFORMANCE	<p>Self-Driving Cars Line Segment Detection Depth Image Fusion</p>
RESEARCH	<p>Global Spectra Analysis Image Classification Global Element Determination Efficient Image Generation Combinatorial Counting & Block Models</p>	RESEARCH	<p>CT Ring Artifact Removal Photomicroscopy & CT Visualization ECG Processing & Visualization</p>

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.

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 ACCELERATION PLATFORMS
IMAGE PROCESSING, COMPUTER VISION, AND RECONSTRUCTION
INDUSTRIAL APPLICATIONS
GRAPHICS, RENDERING, AND DATA 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 APPLICATION PLATFORMS
IMAGE PROCESSING, COMPUTER VISION, AND RECONSTRUCTION
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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://GRDAY.COM/](https://grday.com/)
[HTTPS://INDICO.FKFL.HU/EVENT/1482/](https://indico.fkfl.hu/event/1482/)





THE FUTURE OF MASSIVE PARALLEL AND QUANTUM COMPUTING

EMERSONS ACCELERATED TECHNOLOGIES
HIGH PERFORMANCE COMPUTING AND SUPERCOMPUTING
MODERNIZATION, APPLICATIONS AND REINTEGRATION
MODERNIZATION, APPLICATIONS AND REINTEGRATION
GRAPHICS, RENDERING AND IMAGE CONVERSION
COMPUTING AND VISUALIZATION IN TELECOMUNICATION
QUANTUM COMPUTING DEMONSTRATION
MACHINE LEARNING, NEURAL NETWORKS, FEATURE RECOGNITION
MULTI-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.KFKI.HU/EVENT/1567/](https://indico.kfki.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://GPUDAY2025](https://gpuday2025)
[HTTPS://INDICO.WIGNER.HU/E/GPUDAY2025](https://indico.wigner.hu/e/gpuday2025)

HUN-REN **HUN REN** **wigner** **lombia** **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

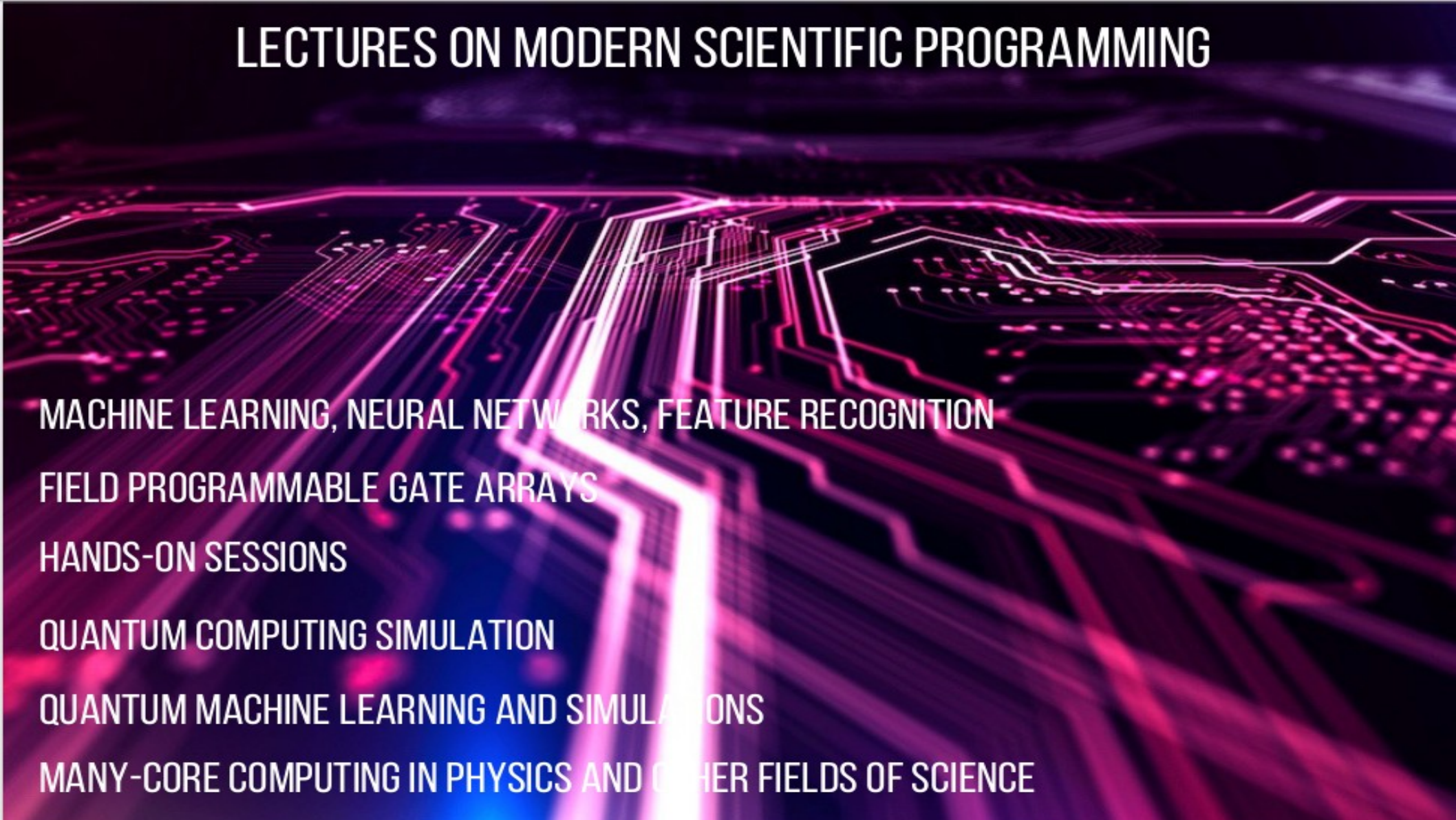
QUANTUM COMPUTING SIMULATION

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

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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

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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

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

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

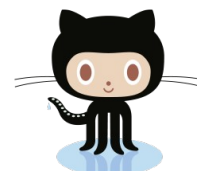
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Tibor Tóth: Head to the Exascale (2019.07.11) 4 views • 2 months ago

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

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

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



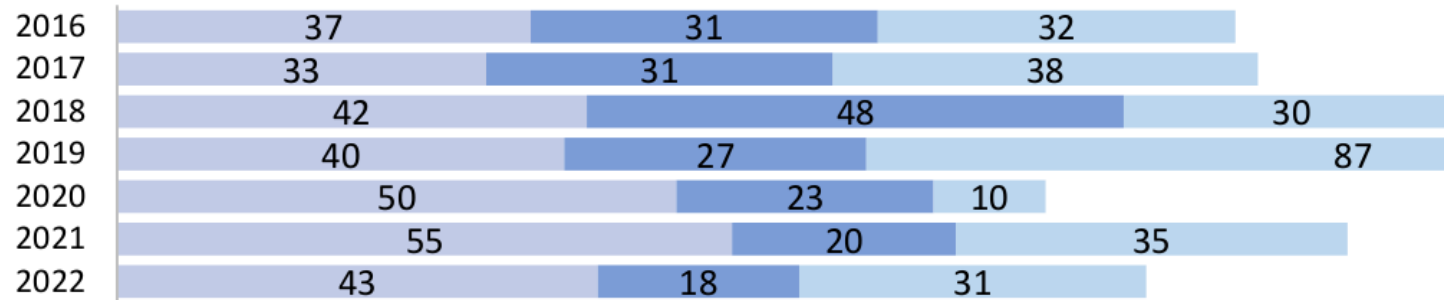
GitHub

PROJECTS>_

WSCLAB in numbers

KNOWLEDGE HUB: GPU DAY.COM

✓ 15 GPU Days

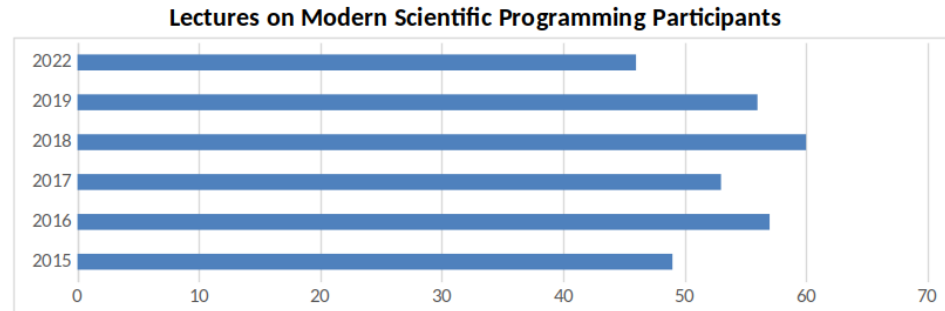


- ✓ 9 Lectures in Modern Computing in Science
- ✓ 65+ WSCLAB (Wigner GPU Lab) Fellowship
- ✓ 40+ industrial & academic partners (Lombiq LTD, Ericsson, 999999, Khronos, CERN...)
- ✓ 80+ scientific publications and program codes

WSCLAB 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)



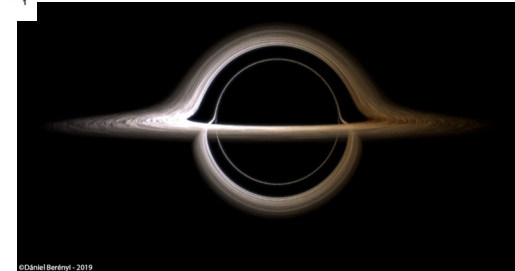
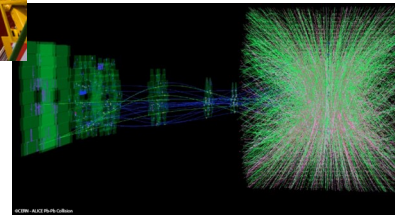
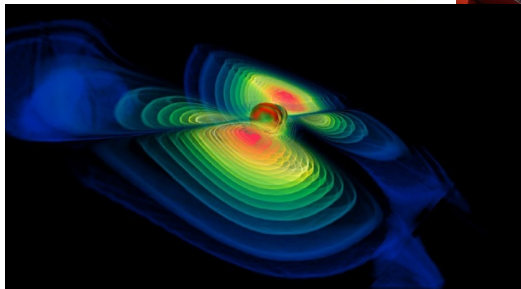
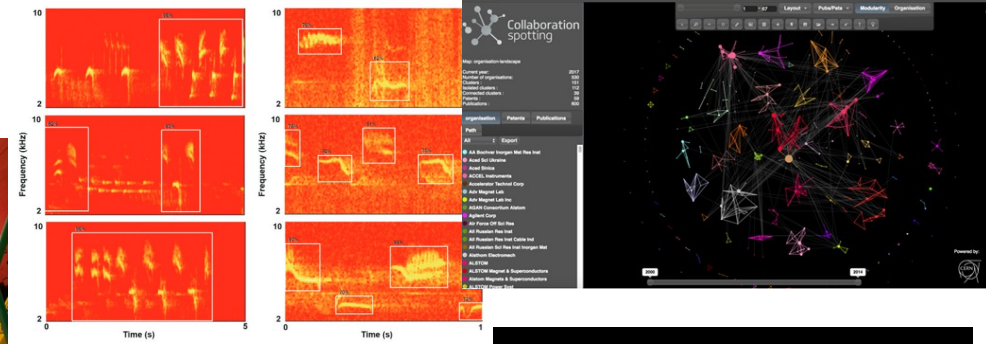
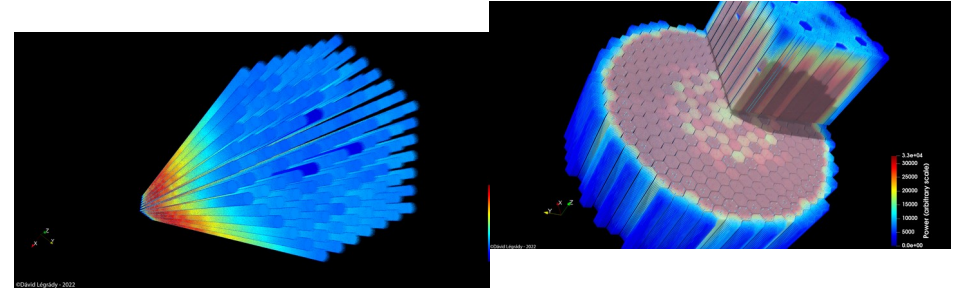
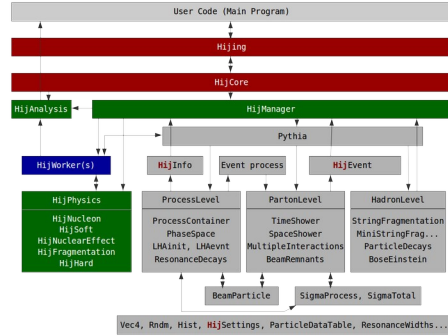
✓ List of Publications

- More than 80 publications & public codes



WSCLAB's SCIENTIFIC PROJECTS

FEW SELECTED ONES



WSCLAB's SCIENTIFIC PROJECTS

FOR THE SOCIETY





FUTURE>_

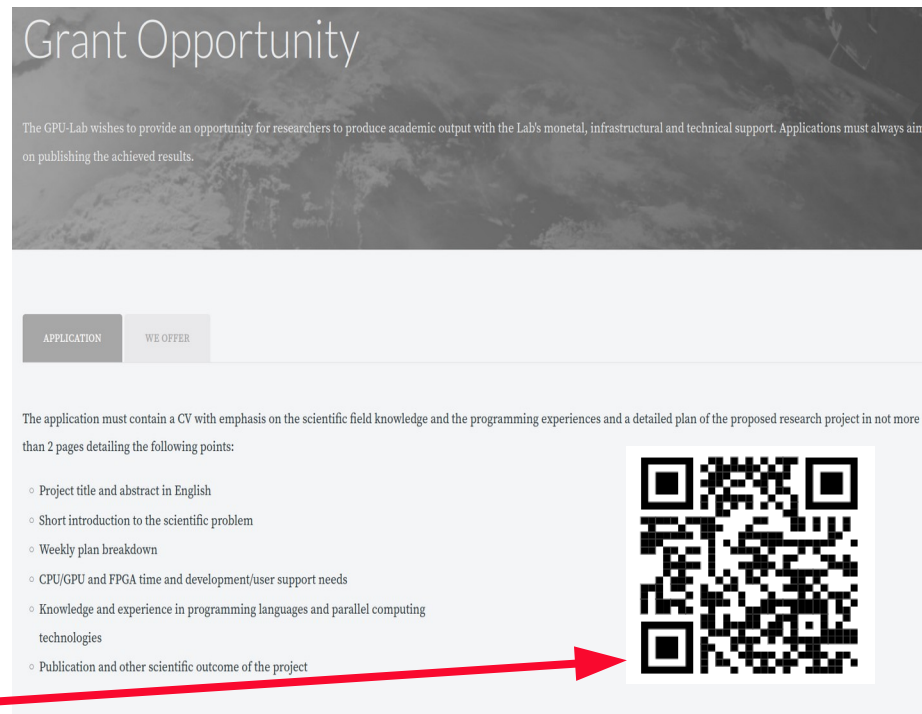
WSCLAB's FUTURE IS IN YOUR HAND

✓ 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'. A red arrow points from the 'How to apply' section of the slide to a QR code located at the bottom right of the application requirements list.


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

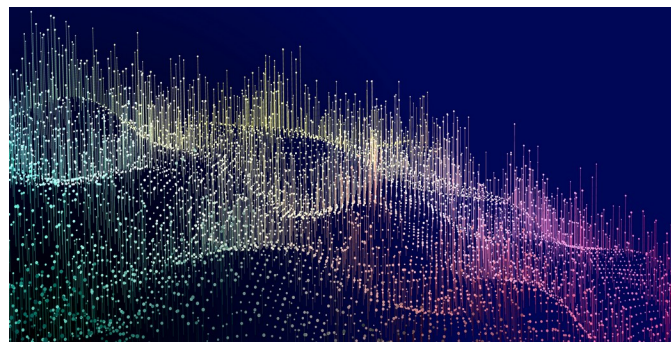
- New WSCLAB Grants for young scientists for 2024
- GPU Day 2025 series (22-23 May 2024)
- Lectures on Modern Computing in Science series (in fall 2025) on QML

✓ Intermediate timescale

- Further local HW developments & cloud solutions

✓ Long range plan

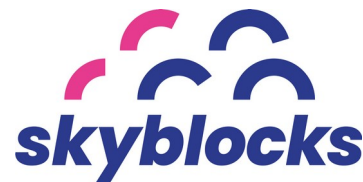
- Closely related to the EuroHPC LEVENTE project including Quantum Computing & Quantum simulations



HUN
REN



HUN-REN
Hungarian Research Network



STREAM
High Performance Computing



HPC @hu
Kompetencia Központ



Cerntech



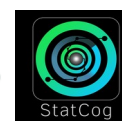
IN2P3
INSTITUT NATIONAL DE PHYSIQUE NUCLÉAIRE
ET DE PHYSIQUE DES PARTICULES



ELKH
Eötvös Loránd
Research Network



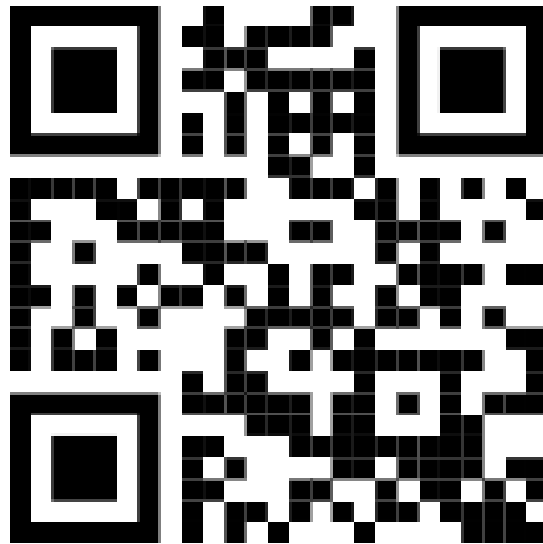
KRONOS
GROUP
CONNECTING SOFTWARE TO SILICON



WSCLAB>_



WIGNER SCIENTIFIC COMPUTING LABORATORY





THX>_



ONE MORE THING>_

ON THE VENUE BY IS IN YOUR HAND

HUN-REN
Hungarian Research Network

- ✓ **Desigend by the Hungarian Dolphin, Alfred Hajós (1878-1955)**
 - First Hungarian olimpic games gold medal winner in 1896 Athen 100m and 1200m
 - Football player and captain
 - Great architect (ecletic & secession)
- ✓ **This building was built in 1911-1912 in premodern style.**

