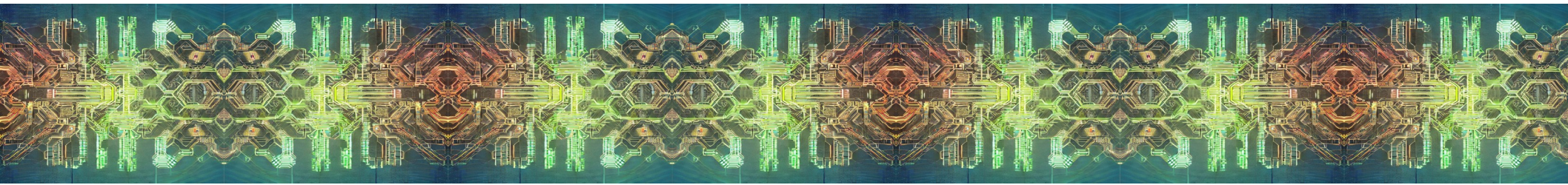
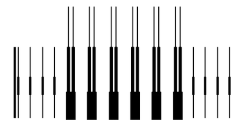


# One Lab – Many Project Review of the WSCLAB's Projects



**Gergely Gábor Barnaföldi**  
**WSCLAB, Wigner Research Centre for Physics**



**MTA**  
Centre  
of Excellence



**ROLE>\_**



# WSCLAB's origin

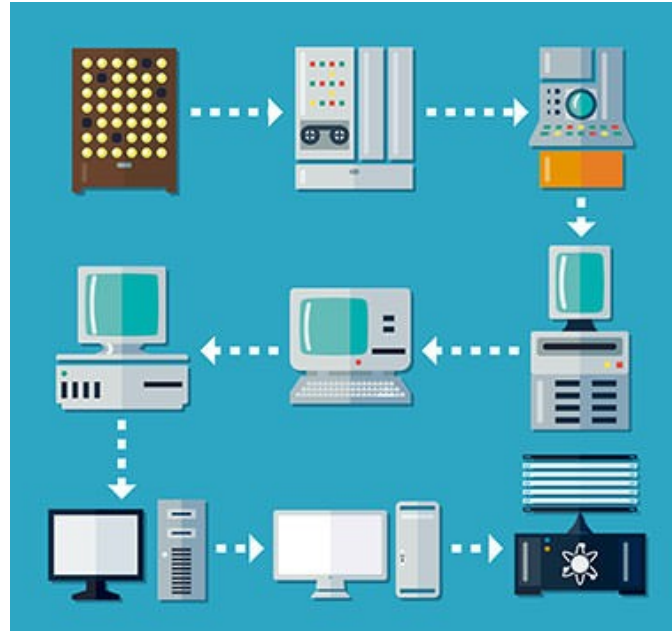
14 YEARS IN PARALLEL COMPUTING (WIGNER GPU LABORATORY) & HPC @ WDC

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

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



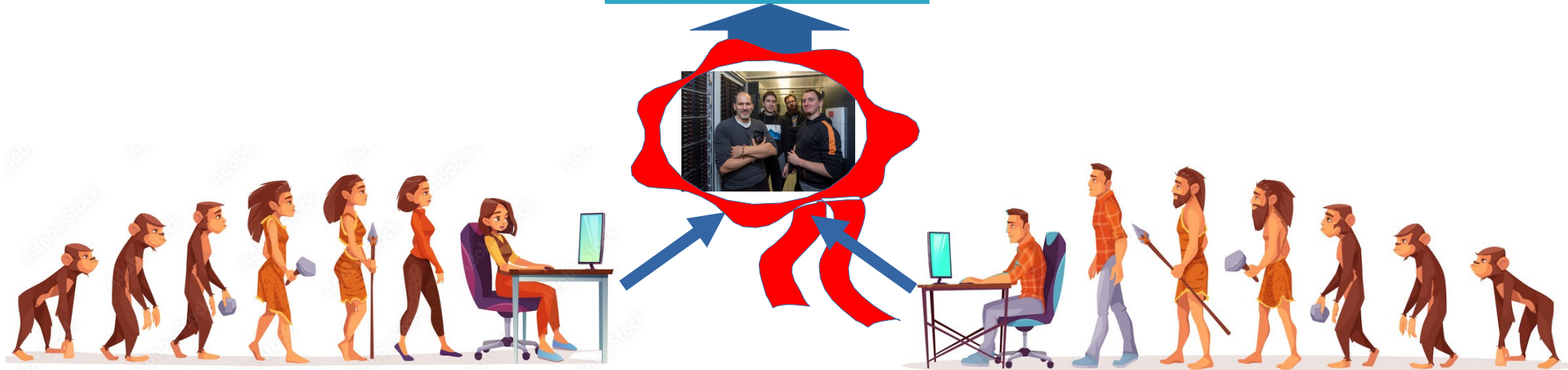
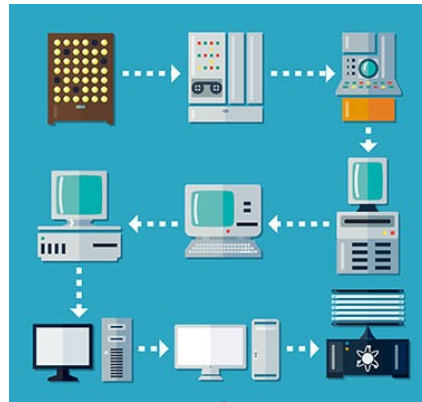
# WSCLAB's role

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



# WSCLAB's role

14 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. Debreczeni

2 main direction: HEP & Gravity

- **2010- 1<sup>st</sup> 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: 17<sup>TH</sup> DECEMBER 2021.



G.G. Barnafoldi: WSCLAB@Jülich 2023





# WSCLAB's origin

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

---

*Since 2010, the GPU Day is a yearly international conference on massively parallel technologies and their applications and quantum computing.*

*Its dedicated goal is to bring together researchers from academia, developers from industry and interested students to exchange experiences and learn about novel and future technologies.*

*It is a unique event with focus on exchange of knowledge and expertise such topics as GPU, FPGA and quantum computing simulations.*

*Presentation of talks and demo desks help to draw attention to your cutting-edge solutions.*

*This conference is an established meeting of experts, where you can discuss methods, exchange ideas, find new collaborators and business partners.*

*Best place to see the Wigner GPU Lab's activity.*

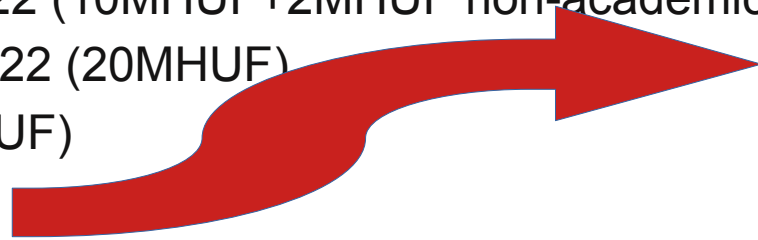
*Our sponsors gain additional visibility at the event, on the webpage and related digital appearances including special interviews.*



# WSCLAB Upgrade Projects

2021.12.01-2024.12.06

- ✓ Massively Parallel Classical- and Quantum Computing Simulations in HEP MassivPara@HEP (2020-2.1.1-ED-2021-00179 25MHUF)
  - Massive parallel computing: Wigner\_AF + GPULab + HIJING++
  - Quantum Computer simulations (Maxeler FPGA)
- ✓ Wigner RCP & INFRA investments @2021 (100MHUF)
- ✓ Young Researcher's Fellowship @2022 (3MHUF)
- ✓ Wigner GPU Laboratory @2022 (10MHUF+2MHUF non-academic)
- ✓ ALICE + CMS WLCG T2 @2022 (20MHUF)
- ✓ 100GBps links @2023 (20MHUF)
  
- ✓ Ongoing & finished projects



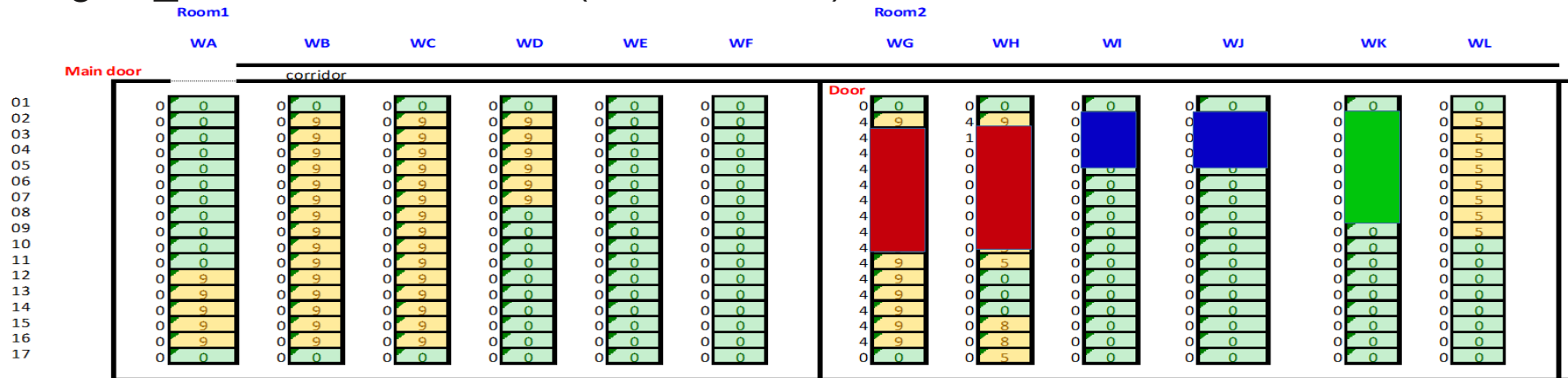


# HARDWARES>\_

# WSCLAB @ WDC

## THE PLACE

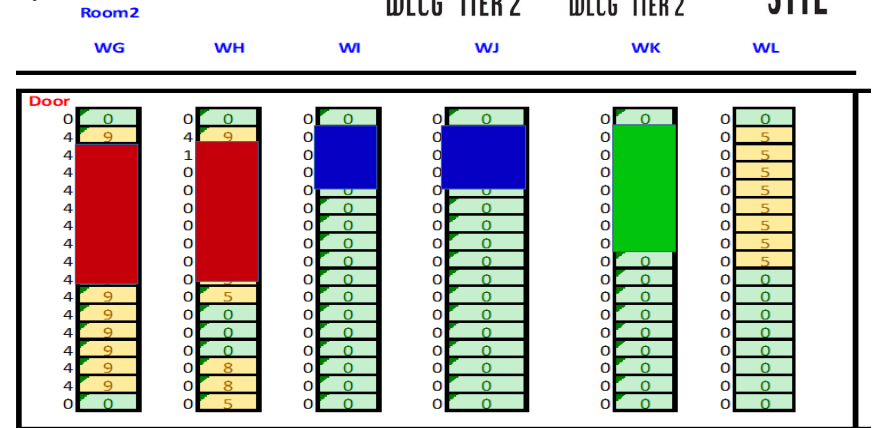
- ✓ Wigner Analysis Facility (Wigner AF)
- ✓ Wigner GPU Laboratory
- ✓ Wigner\_KFKI WLCG T2 Grid (ALICE+CMS)



# WSCLAB @ WDC

## THE PLACE

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





ALICE

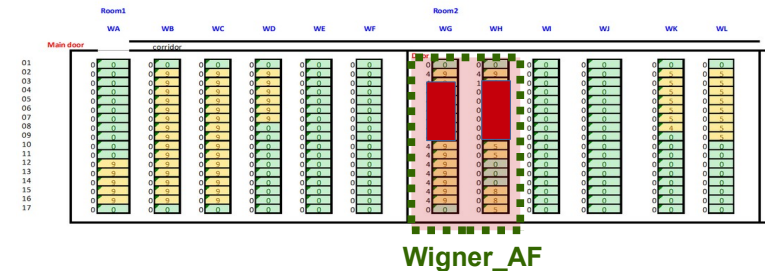
ANALYSIS FACILITY

# WIGNER\_AF

NEW SPECIALIZED HEP ANALYSIS FACILITY (1<sup>ST</sup> FOR ALICE)

## ✓ 1) HW 9 rack of hardware

- SE: EOS config & monitoring
  - 100Gbps link to GEANT
  - 2 redundant MGM nodes
  - 32 FST node, with 24\*3 TB for each node
  - Raw capacity: ~2.6 PB
  - Usable capacity: ~1.3 PB
- WNs: configured with HTCondor, 1 single-core queue and 1 multi-core queue (for 8-core jobs)
  - 124 worker nodes, with 32 vCPU for each node
  - Pool is shared among two queues, but the single-core queue is limited



# WIGNER\_AF & ALICE T2 2022Q2 PERFORMANCE

✓ Wigner\_AF\_8\_core:

✓ Wigner\_AF:



## The Wigner ALICE Analysis Facility

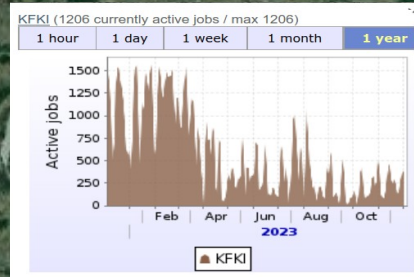
✓ WIGNER\_KFKI:

Gábor Bíró<sup>1,2</sup>, Gergely Gábor Barnaföldi<sup>1</sup>, Péter Lévai<sup>1</sup>, Latchezar Betev<sup>3</sup> and Jan Fiete Grosse-Oetringhaus<sup>3</sup>

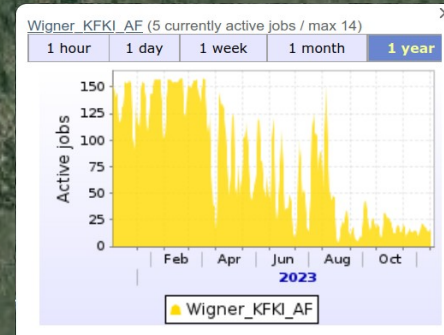


# WIGNER\_AF & ALICE T2 PERFORMANCE

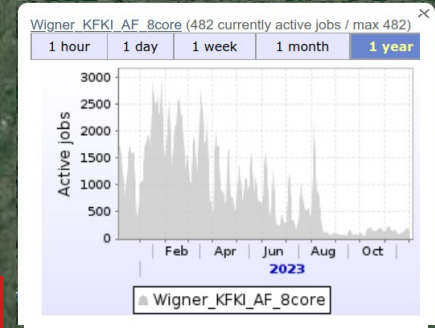
✓ Wigner\_AF\_8\_core:



✓ Wigner\_AF:



✓ WIGNER\_KFKI:



WIGNER\_KFKI

Wigner\_KFKI\_AF\_8core  
Wigner\_KFKI\_AF



ALICE



**WLCG TIER 2**



**WLCG TIER 2**



**SITE**



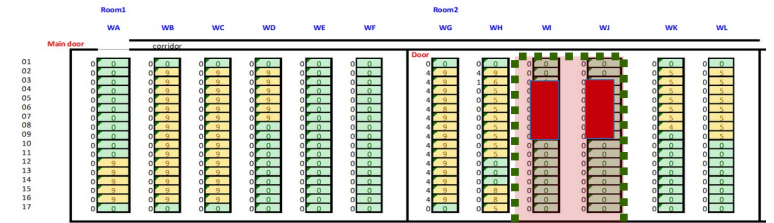


**GPU Laboratory**

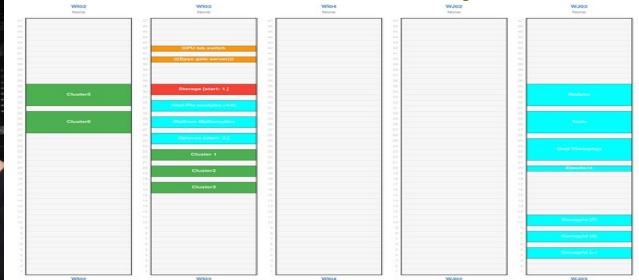
## Wigner GPU Laboratory (@WDC) HARDWARES

### ✓ 3) Wigner WSCLAB's GPU Lab picks

- 20 TB Storage Element
- 100 Gbps switch to GEANT
- Mathematica WN server
- Supermicro EPYC +8x A100
- EPYC + 6x Nvidia Tesla T4
- EPYC + 8xNvidia A2
- Maxeller 2xFPGA (Xilinx Alveo)
- EPYC gate server
- Infiniband switch & cards



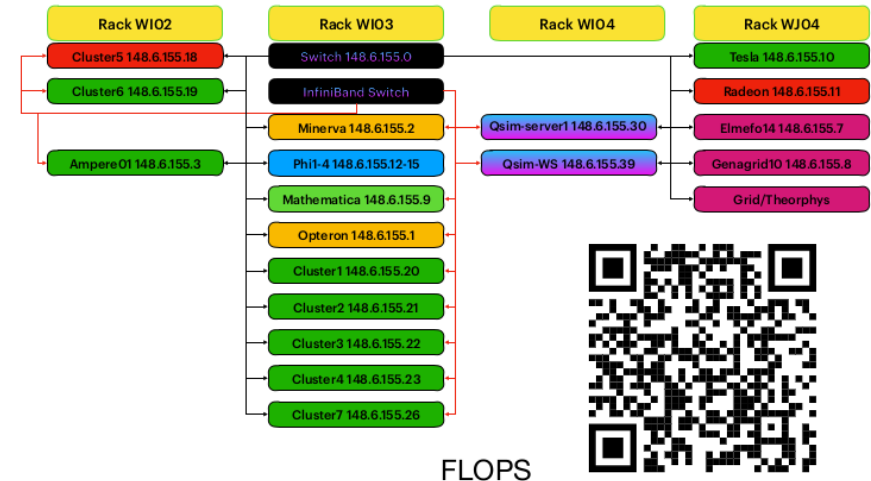
Wigner GPU Laboratory



## Wigner GPU Laboratory (@WDC) HARDWARES

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- 20 TB Storage Element
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- Maxeller 2xFPGA (Xilinx Alveo)
- EPYC gate server
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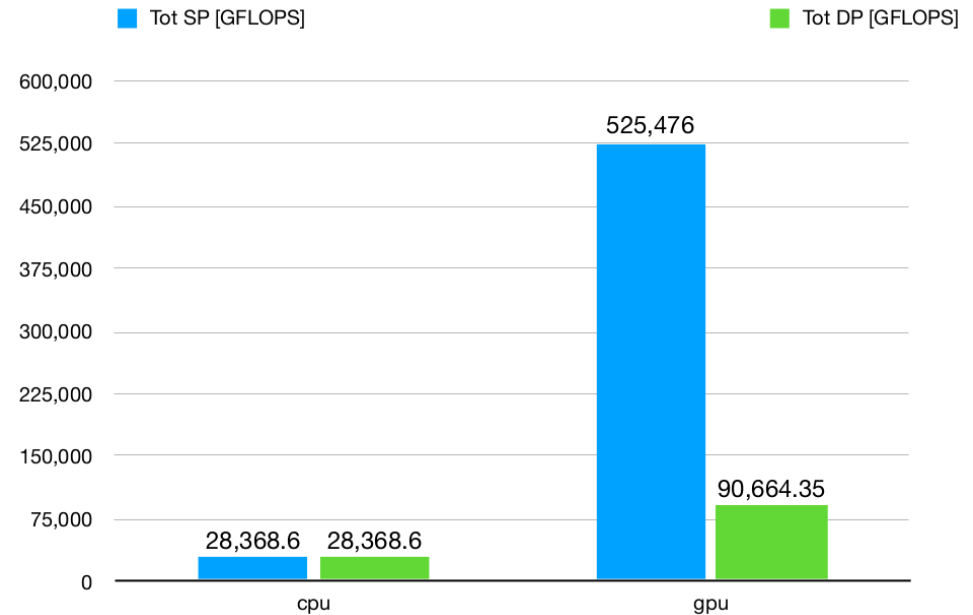
	cpu	gpu	Total Mem
Tot SP [GFLOPS]	28,368.6	525,476	3,056 GB
Tot DP [GFLOPS]	28,368.6	90,664	

# Wigner GPU Laboratory (@WDC)

## HARDWARES

### ✓ 3) Wigner WSCLAB's GPU Lab picks

- 20 TB Storage Element
- 100 Gbps switch to GEANT
- Mathematica WN server
- Supermicro EPYC +8x A100
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- EPYC + 8xNvidia A2
- Maxeller 2xFPGA (Xilinx Alveo)
- EPYC gate server
- Infiniband switch & cards





# EVENTS>\_



# WIGNER SCIENTIFIC COMPUTING LABORATORY

## GPU DAY 2022

---

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



# GPU Days so far...

## 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

**gpu 2011**  
GPU programozás a tudományos kutatásokban

PROGRAM:

- 09:00 Regisztráció
- 09:30 Munka
- 10:00 GPU az API-alkalmazásban
- 10:30 Grafikus kártyák mint asztali szuperszámítógépek
- 11:00 Molekuladinamika számítások GPU-val
- 11:30 Rács QCD és részecskefizikai alkalmazások
- 12:00 Munka
- 13:00 GPU a kísérleti és elméleti gravitációkutatásban
- 14:00 Munka
- 15:00 GPU programozás gyakorlat

REGISZTRÁCIÓ: <http://gpu.kfki.hu>

**gpu@2012**  
GPU programozás a tudományos kutatásokban

PROGRAM:

- 09:00 Regisztráció
- 09:30 Munka
- 10:00 GPU az API-alkalmazásban
- 10:30 Grafikus kártyák mint asztali szuperszámítógépek
- 11:00 Molekuladinamika számítások GPU-val
- 11:30 Rács QCD és részecskefizikai alkalmazások
- 12:00 Munka
- 13:00 GPU a kísérleti és elméleti gravitációkutatásban
- 14:00 Munka
- 15:00 GPU programozás gyakorlat

REGISZTRÁCIÓ: <http://gpu.kfki.hu>

**gpu@2013**  
GPU programozás a tudományos kutatásokban

PROGRAM:

- 09:00 Regisztráció
- 09:30 Munka
- 10:00 GPU az API-alkalmazásban
- 10:30 Grafikus kártyák mint asztali szuperszámítógépek
- 11:00 Molekuladinamika számítások GPU-val
- 11:30 Rács QCD és részecskefizikai alkalmazások
- 12:00 Munka
- 13:00 GPU a kísérleti és elméleti gravitációkutatásban
- 14:00 Munka
- 15:00 GPU programozás gyakorlat

REGISZTRÁCIÓ: <http://gpu.kfki.hu>

**FUTURE OF MANY-CORE COMPUTING IN SCIENCE**

**MAY 20 2014**

PROGRAM:

- 09:00 Regisztráció
- 09:30 Munka
- 10:00 GPU az API-alkalmazásban
- 10:30 Grafikus kártyák mint asztali szuperszámítógépek
- 11:00 Molekuladinamika számítások GPU-val
- 11:30 Rács QCD és részecskefizikai alkalmazások
- 12:00 Munka
- 13:00 GPU a kísérleti és elméleti gravitációkutatásban
- 14:00 Munka
- 15:00 GPU programozás gyakorlat

REGISZTRÁCIÓ: <http://gpu.kfki.hu>

**GPU DAY 2015**  
The Future of Many-Core Computing in Science

**2015 May 20-21 WED-THU**

KEYNOTE: INTRODUCTION

SPECIAL TOPICS

CONTRIBUTED

REGISTRATION: <http://gpu.kfki.hu>

**5th GPU DAY**  
The Future of Many-Core Computing in Science

**2nd JUN**

PROGRAM:

- 09:00 Regisztráció
- 09:30 Munka
- 10:00 GPU az API-alkalmazásban
- 10:30 Grafikus kártyák mint asztali szuperszámítógépek
- 11:00 Molekuladinamika számítások GPU-val
- 11:30 Rács QCD és részecskefizikai alkalmazások
- 12:00 Munka
- 13:00 GPU a kísérleti és elméleti gravitációkutatásban
- 14:00 Munka
- 15:00 GPU programozás gyakorlat

REGISZTRÁCIÓ: <http://gpu.kfki.hu>

**GPU DAY 2019**  
The Future of Computing, Graphics and Data Analysis

**11-12 07 2019**

PROGRAM:

- 09:00 Regisztráció
- 09:30 Munka
- 10:00 GPU az API-alkalmazásban
- 10:30 Grafikus kártyák mint asztali szuperszámítógépek
- 11:00 Molekuladinamika számítások GPU-val
- 11:30 Rács QCD és részecskefizikai alkalmazások
- 12:00 Munka
- 13:00 GPU a kísérleti és elméleti gravitációkutatásban
- 14:00 Munka
- 15:00 GPU programozás gyakorlat

REGISZTRÁCIÓ: <http://gpu.kfki.hu>

**WIGNER GPU LABORATORY PRESENTS**

**GPU DAY 2021**

**10-11. NOVEMBER**

MORE INFORMATION AND REGISTRATION:  
[HTTPS://GPUDAY.COM/](https://gpuday.com/)  
[HTTPS://INDICO.KFKI.HU/EVENT/1330/](https://indico.kfki.hu/event/1330/)

KEYNOTE SPEAKERS: ALBERTO DI MEGLIO, OSKAR MENCER

THE FUTURE OF MASSIVE PARALLEL AND QUANTUM COMPUTING

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**WIGNER SCIENTIFIC COMPUTING LABORATORY**

**GPU DAY 2022**

**20-21. JUNE**

MORE INFORMATION AND REGISTRATION:  
[HTTPS://GPUDAY.COM/](https://gpuday.com/)  
[HTTPS://INDICO.KFKI.HU/EVENT/1393/](https://indico.kfki.hu/event/1393/)

THE FUTURE OF MASSIVE PARALLEL AND QUANTUM COMPUTING

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**WIGNER SCIENTIFIC COMPUTING LABORATORY**

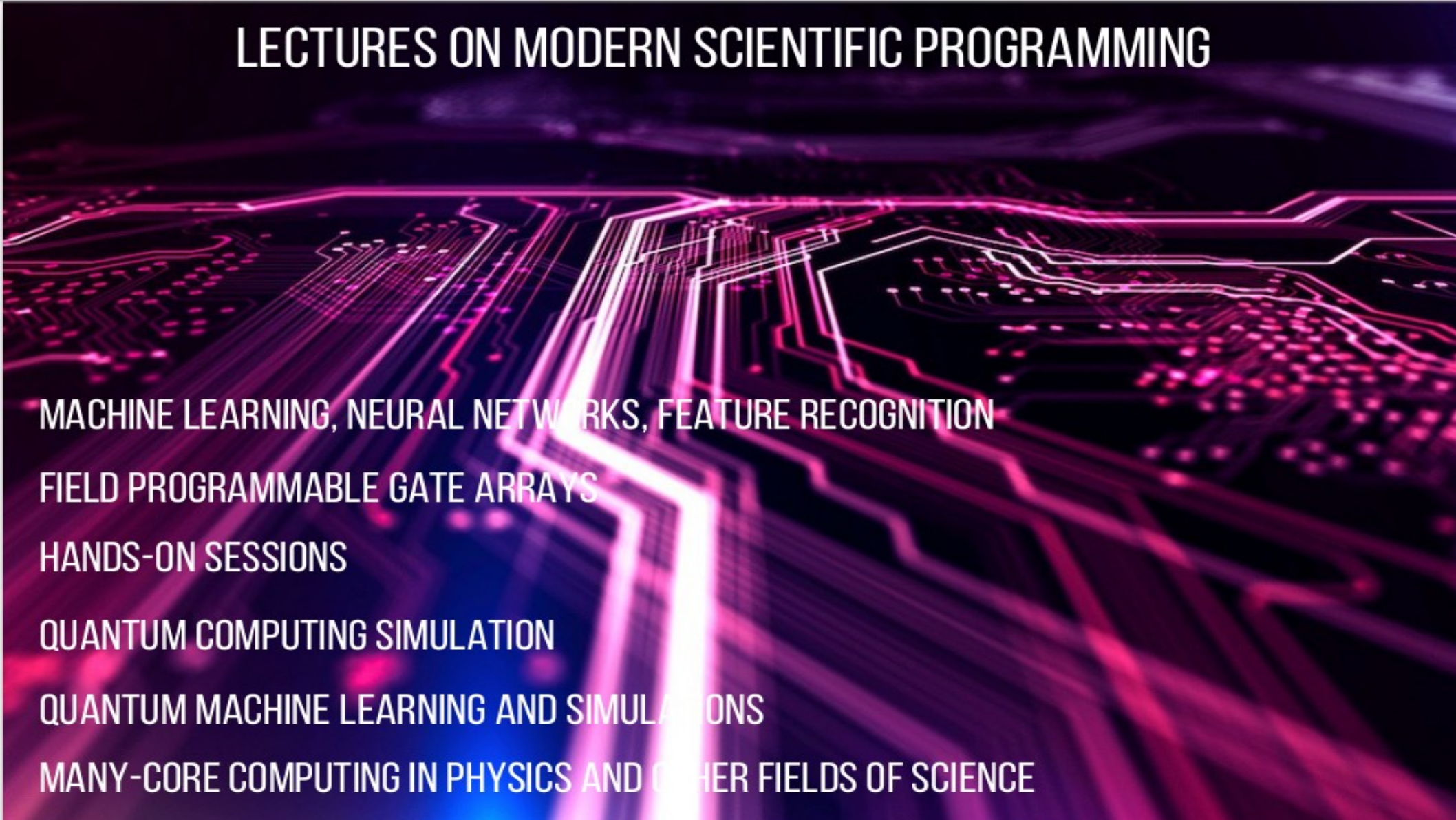
**GPU DAY 2023**

**15-16. MAY**

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



# 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 stars 0 issues 0 forks Updated on Sep 26, 2019

## SYCL-PRNG

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

C++ 1 star 4 issues 0 forks Updated on Jun 11, 2019

## Teaching

Material used for teaching.

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

## HaladoAlkProg

Code samples for the "Haladó Alkalmazott Programozás" course

C++ MIT 0 stars 0 issues 0 forks Updated on May 15, 2019

## LOMSP

Sample codes from the Lectures On Modern Scientific Programming series

C++ 1 star 1 issue 0 forks Updated on Feb 14, 2018

## SchwarzschildRaytracer

Raytracer in the Schwarzschild metric for visualization

C++ 1 star 0 issues 0 forks Updated on Jun 2, 2017

**wigner GPU Lab** 54 subscribers [SUBSCRIBE](#)

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Bálint Györes-Tóth: Enhanced Sequence Modeling with... 41 views • 1 year ago

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



GitHub



# PROJECTS>\_

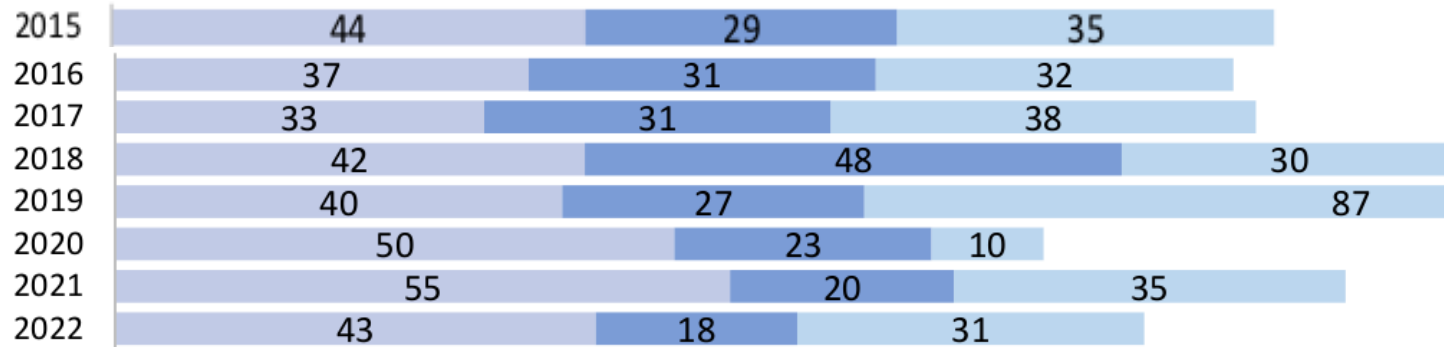




# WSCLAB in numbers

KNOWLEDGE HUB: GPU DAY.COM

- ✓ 9 Lectures on Modern Computing in Science
- ✓ 13 GPU Days



- ✓ 50 WSCLAB (Wigner GPU Lab) Fellowship (40 finished + 9 running)
- ✓ 35+ industrial & academic partners (Lombiq LTD, Ericsson, Khronos, CERN...)
- ✓ 60+ scientific publications and program codes

# WSCLAB's SCIENTIFIC RESULTS

## BASED ON THE PROJECTS

### ✓ Finished Projects from various fields

- Astronomy & Astrophysics (12)
- Physics (15)
- Biochemistry (5)
- Life & Medical Sciences, Etology/Ornitology (5)
- Computational Sciences, Imaging, Simulations (11)
- Quantum Computing (6)



### ✓ List of Publications

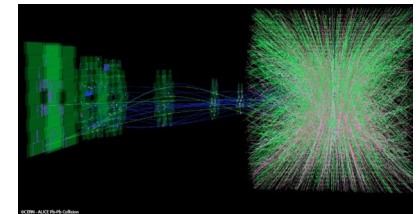
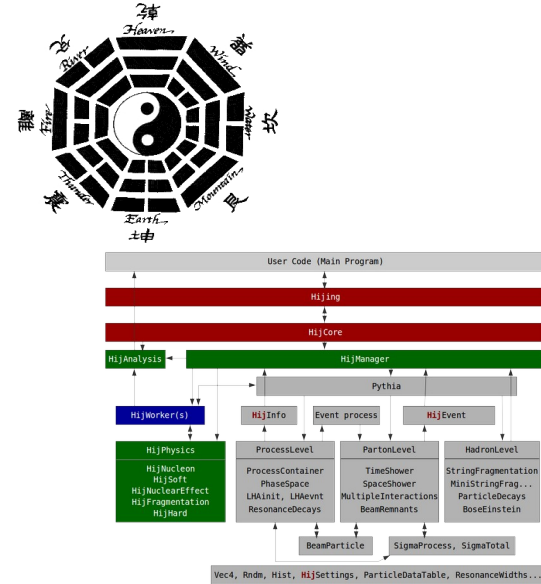
- More than 60 publications & public codes



# WSCLAB's SCIENTIFIC PROJECTS

## FEW SELECTED ONES

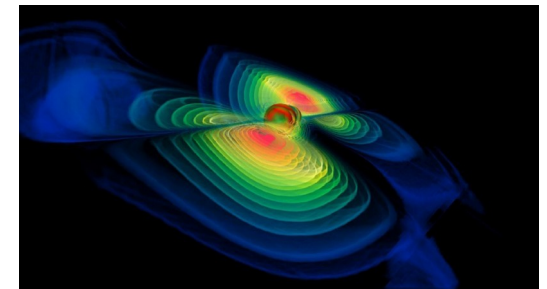
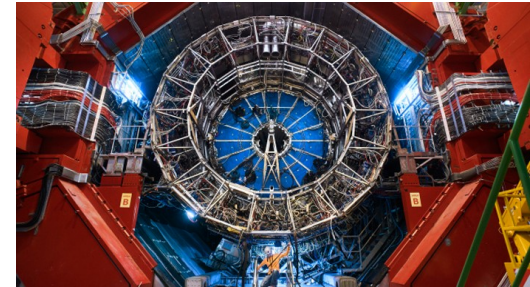
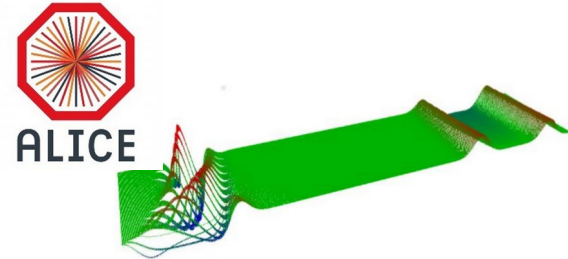
- ✓ Simulating the photo-ionisation of Rubidium atoms
- ✓ **High Performance Computing for Nanofusion**
- ✓ High performance Monte Carlo simulations of high-energy heavy-ion collisions
- ✓ **Modelling non-linear optics by machine learning techniques**
- ✓ Generation of Gravitational Wave Signals with Parallel methods
- ✓ Studying Hadronization by Machine Learning Techniques
- ✓ Modelling of polygons on rotating fluid surface with the parameters of real-life experiments



# WSCLAB's SCIENTIFIC PROJECTS

## PHYSICS (15)

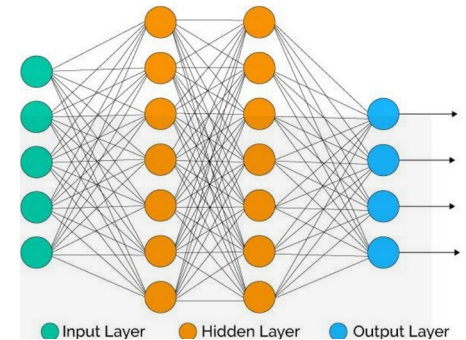
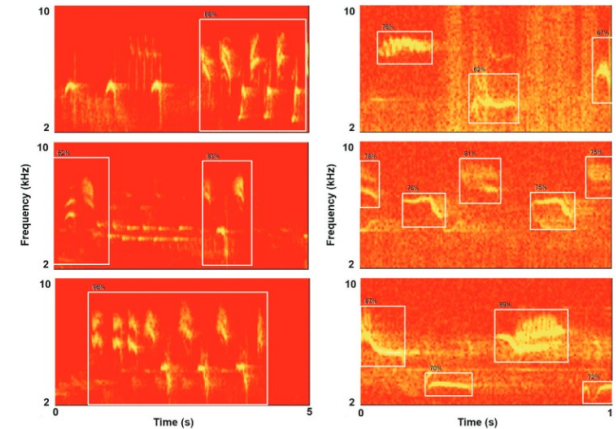
- ✓ Optimization and Development of High-performance Computing pipeline to search for gravitational radiation from rotating NS by means of GPU-based Hardware Accelerators
- ✓ ALICE TCP GEM QA – GPU-accelerated image analysis
- ✓ Viscous corrections from linearized Boltzmann transport
- ✓ Parallelized Transport and Corrections to Equilibrium Phase Space Distributions
- ✓ Numerical Studies of Lattice Loop Equations in Pure Gauge Theory
- ✓ Construction of known waveforms – like OJ287 – with PYCBC
- ✓ Detection estimates for gravitational binary sources



# WSCLAB's SCIENTIFIC PROJECTS

LIFE SCIENCES, CHEMISTRY, ORNITOLOGY (5)

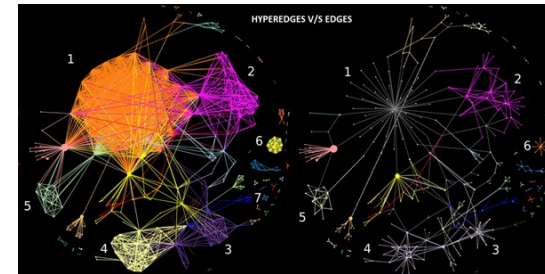
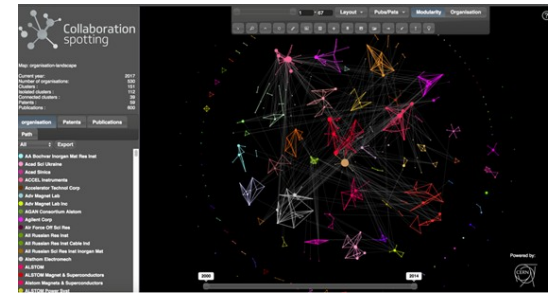
- ✓ **Analysis of the spatial structure of SARS-CoV-2 protein using machine learning methods**
- ✓ Quantum chemical study of the hydrolysis of oxidized endogenous psychedelic N,N-dimethyltryptamine
- ✓ N,N-dimethyltryptamine metabolism by the monoamine oxidase enzyme-A
- ✓ In silico studies to uncover the effect of CFTR mutants causing cystic fibrosis
- ✓ **Detection of the songs of collared flycatcher (*Ficedula albicollis*) with the help of deep neural networks**



# WSCLAB's SCIENTIFIC PROJECTS

## IMAGING, SIMULATIONS, COMPUTING (11)

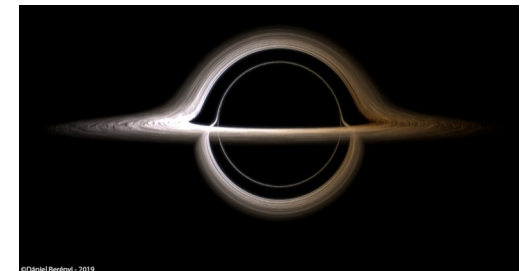
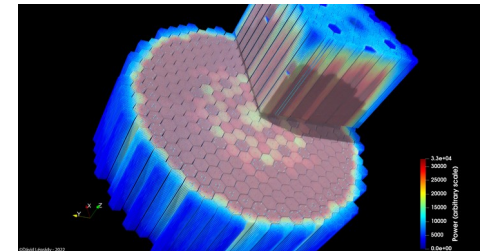
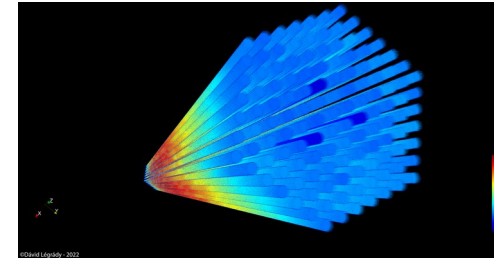
- ✓ 3D iterative image reconstruction software developed for proton computed tomography imaging
- ✓ Biasing the GUARDYAN GPU-based Monte Carlo code using space-, energy- and angle-dependent adjoint function
- ✓ **Evaluation of proton tomography measurements with neural networks for hadron therapy**
- ✓ Stochastic causality
- ✓ Implementing Hastlayer support for Xilinx SoC Zynq FPGA family I. And II.



# WSCLAB's SCIENTIFIC PROJECTS

IMAGING, SIMULATIONS, COMPUTING (11)

- ✓ **Full Core Pin-Level VVER-440 Simulation of a Rod Drop Experiment with the GPU-Based Monte Carlo Code GUARDYAN**
- ✓ Eötvös balance camera photo evaluation
- ✓ Implementing support for high-performance Microsoft Catapult FPGAs in the Hastlayer .NET high-level synthesis toolbox
- ✓ **Graph visualization of the human brain's structural and functional organization**
- ✓ Data processing algorithm development for parallel architectures



# WSCLAB's SCIENTIFIC PROJECTS

ASTRONOMY, ASTROPHYSICS, COSMOLOGY (12)

- ✓ **Examination of seasonal polar ice cap edge in the southern hemisphere of Mars**
- ✓ A dynamical survey of trans-Neptunian space I. mean motion resonances with Neptune
- ✓ A dynamical survey of the trans-Neptunian space II.: Diffusion and stability
- ✓ Entropy based stability analysis of planetary systems retrieved from scalar time series
- ✓ **Shock waves in partially ionised prominence plasmas**
- ✓ Statistical study of mean motion resonances and physical properties of Hungarian asteroids using FAIR
- ✓ The evolution of sunspots I. Lifetime and asymmetric evolution

# WSCLAB's SCIENTIFIC PROJECTS

ASTRONOMY, ASTROPHYSICS, COSMOLOGY (12)

- ✓ **Study of Cosmological Large Scale Structure with GPU-accelerated N-body Simulations**
- ✓ Light curve modeling of close binary and multiple systems
- ✓ Investigation of the K2 Mission's Star System's Eclipse Mean Times
- ✓ Large Scale Lightcurve Analysis
- ✓ The study of the effect of the cosmological constant with the GW150914

# WSCLAB's SCIENTIFIC PROJECTS

## QUANTUM COMPUTING & TECHNOLOGY (6)

- ✓ Polynomial speedup in Torontonian calculation by a scalable recursive algorithm
- ✓ **Highly optimized quantum circuits synthesized via data-flow engines**
- ✓ Efficient quantum gate decomposition via adaptive circuit compression
- ✓ Approaching the theoretical limit in quantum gate decomposition
- ✓ GPU based simulation of strongly correlated quantum systems
- ✓ **Accelerating Quantum Computer Simulators with GPUs**





**FUTURE>\_**

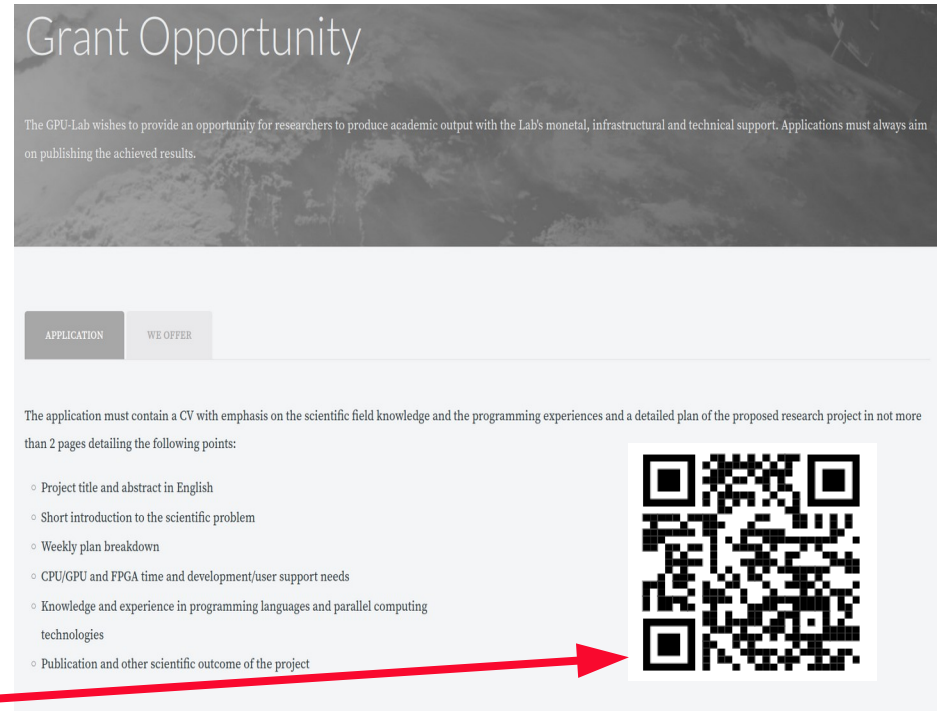
# WSCLAB's FUTURE IS IN YOUR HAND

## ✓ 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](http://wsclab.wigner.hu)



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

A red arrow points from the text 'How to apply' to a QR code located in the bottom right corner of the webpage screenshot.

# WSCLAB's FUTURE

## PLANS FOR THE FUTURE

### ✓ Short timescale

- New WSCLAB Grants for young scientists for 2024
- GPU Day 2024 series (in May/June 2024)
- Lectures on Modern Computing in Science series (in fall 2024)

### ✓ Intermediate timescale

- Further local HW developments & cloud solutions

### ✓ Long range plan

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







# WSCLAB>\_



WIGNER SCIENTIFIC COMPUTING LABORATORY





THX>\_





**BACKUP>\_**

## Wigner GPU Laboratory (@WDC) HARDWARE DETAILS

		db	Single Precision [GFLOPS]	Double Precision [GFLOPS]	Tot SP [GFLOPS]	Tot DP [GFLOPS]
CPU	AMD EPYC 7742	2	2,513	2,513	5,026.0	5,026.0
GPU	NVIDIA A100-SXM4 HBM2e 80GB	8	19,490.00	9,746.00	155,920.00	77,968.00
Memory	64GB Samsung 3200MHz DDR4 ECC Registered DIMM	32	64 GB		sum:	2,048 GB
Modell	Supermicro A+ Server 4124GO-NART+					
Alaplap	H12DGO-6					

### Qsim-server1

		db	Single Precision [GFLOPS]	Double Precision [GFLOPS]	Tot SP [GFLOPS]	Tot DP [GFLOPS]
Alaplap	GIGABYTE MZ92-FS0-00					
CPU	AMD EPYC 7543	2	1433.6	1433.6	2,867.2	2,867.2
FPGA	Maxeler FPGA (Xilinx Alveo U250)	2	2,035	2,035	4,071	4,071
Memory	16GB Micron 3200MHz DDR4 ECC RDIMM	16	16 GB		sum:	256 GB

### Qsim-workstation

		db	Single Precision [GFLOPS]	Double Precision [GFLOPS]	Tot SP [GFLOPS]	Tot DP [GFLOPS]
Alaplap	Supermicro M12SWA-TF					
CPU	AMD Ryzen Threadripper PRO 3955WX	1	998.4	998.4	998.4	998.4
FPGA	Maxeler FPGA (Xilinx Alveo U250)	1	2,035	2,035	2,035	2,035
Memory	16GB SK Hynix 3200MHz DDR4 ECC RDIMM	4	16 GB		sum:	64 GB



## Wigner GPU Laboratory (@WDC) HARDWARE DETAILS

		db	Single Precision [GFLOPS]	Double Precision [GFLOPS]	Tot SP [GFLOPS]	Tot DP [GFLOPS]
Alaplap	ESC8000 G4					
CPU	Intel® Xeon Gold 5122	2	460.8	460.8	921.6	921.6
GPU	AMD Radeon RX Vega 64	6	8,286	518	49,716	3,108
Memory	16GB Micron DDR4 2666MHz ECC	12	16 GB		sum:	192 GB

### Cluster 6

		db	Single Precision [GFLOPS]	Double Precision [GFLOPS]	Tot SP [GFLOPS]	Tot DP [GFLOPS]
Alaplap	ESC8000 G4					
CPU	Intel® Xeon Gold 5122s	2	460.8	460.8	921.6	921.6
GPU	NVIDIA Tesla T4	8	8,141	254	65,128	2,035
Memory	16GB Micron DDR4 2666MHz ECC	12	16 GB		sum:	192 GB

### Cluster 7

		db	Single Precision [GFLOPS]	Double Precision [GFLOPS]	Tot SP [GFLOPS]	Tot DP [GFLOPS]
Alaplap	4124GS-TNR					
CPU	AMD EPYC™ 7302	2	768.0	768.0	1,536.0	1,536.0
GPU	NVIDIA® A2	8	4,531.0	70.8	36,248.0	566.4
Memory	16GB Micron 3200MHz DDR4 ECC RDIMM	16	16 GB		sum:	256 GB



# GPU Laboratory

## Wigner GPU Laboratory (@WDC)

### HARDWARE DETAILS

Phi 1 – 4

		db	Single Precision [GFLOPS]	Double Precision [GFLOPS]	Tot SP [GFLOPS]	Tot DP [GFLOPS]
Alaplap	Intel® Xeon Server Compute Module					
CPU	Intel® Xeon 7250		3046	3046	12,184.0	12,184.0
Memory	16GB Micron DDR4 2666MHz ECC	6	8 GB		sum:	48 GB

Mathematica

		db	Single Precision [GFLOPS]	Double Precision [GFLOPS]	Tot SP [GFLOPS]	Tot DP [GFLOPS]
Alaplap	ESC4000 G4S					
CPU	AMD EPYC 7502P	1	1,585.0	1,585.0	1,585.0	1,585.0
GPU	NVIDIA GeForce GTX 980 Graphics	2	4,612	144	9,224	288
	Nvidia GeForce GTX 1080 Ti	2	11,340	354	22,680	709
Memory	32GB Kingston 3200MHz DDR4 ECC Reg CL22 DIMM	8	32 GB		sum:	256 GB

		db	Single Precision [GFLOPS]	Double Precision [GFLOPS]	Tot SP [GFLOPS]	Tot DP [GFLOPS]
Alaplap	ASUS RS924A-E6/RS8					
CPU	AMD Opteron™ 6376	4	294.3	294.3	1,177.2	1,177.2
GPU	AMD Radeon R9 270X Graphics	2	2,560	160	5,120	320
Memory	32GB 1333MHz DDR3L ECC Reg CL9 DIMM	4	32 GB		sum:	128

EPYC Kapugép

		db	Single Precision [GFLOPS]	Double Precision [GFLOPS]	Tot SP [GFLOPS]	Tot DP [GFLOPS]
Alaplap	Supermicro 1014S-WTRT					
CPU	AMD EPYC™ 7262	1	409.6	409.6	409.6	409.6
Memory	16GB Micron 3200MHz DDR4 ECC RDIMM	8	8 GB		sum:	64