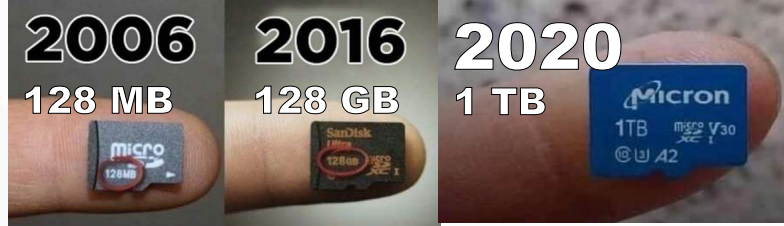# HEP COMPUTING IN HUNGARY

RECFA meeting
Budapest, Hungary
23 09 2022

GÁBOR BÍRÓ
biro.gabor@wigner.hu

Worldwide LHC Computing Grid – up to now
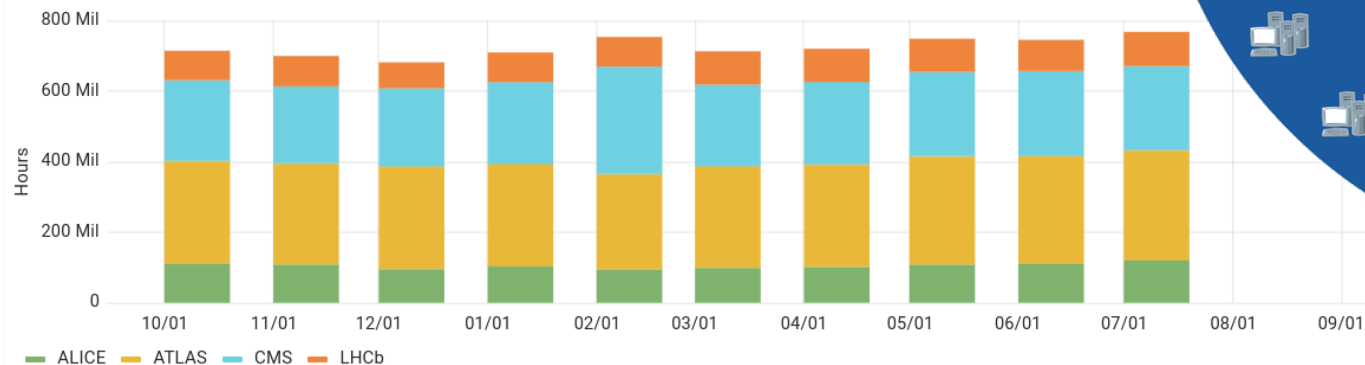

WLCG — Worldwide LHC Computing Grid

2006	2016	2020
128 MB	128 GB	1 TB

LHC numbers in **2013** vs. **now**:

Data:	15 PB/y	vs	200+ PB/y
Tape:	180 PB	vs	740+ PB
Disk:	200 PB	vs	570+ PB
HS06 hours:	2M	vs	100+ B

Tier-2 sites (about 160)

Tier-1 sites

>100 Gb/s links

KIT Karlsruhe, Germany

BNL Brookhaven, NY - USA

NDGF Nordic countries

SARA-NIKHEF Amsterdam, Netherlands

RU-T1 Moscow, Russia

RAL Oxfordshire, UK

ASGC Taipei

Tier-0

FNAL Batavia, Il USA

PIC Barcelona, Spain

TRIUMF Vancouver, Canada

CCIN2P3 Lyon, France

INFN - CNAF Bologna, Italy

KISTI-GSDC Daejeon, Rep. of Korea
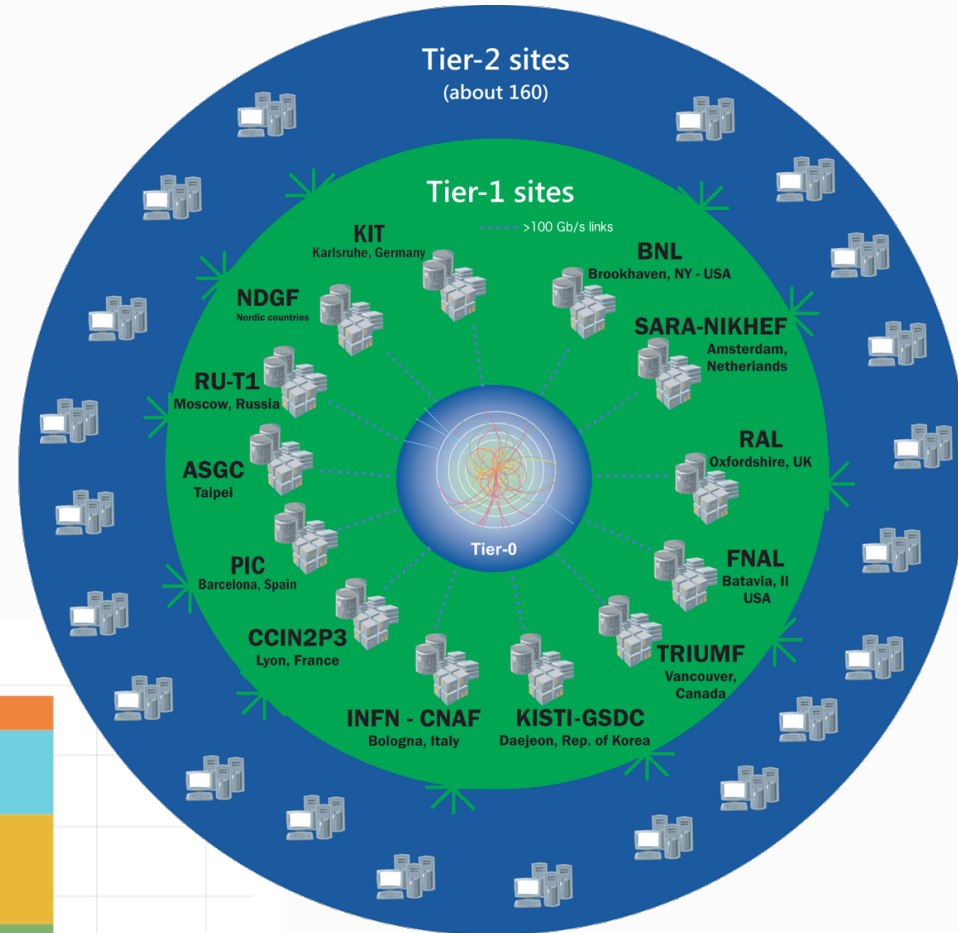
Wall-Clock Time (in hours)

ALICE · ATLAS · CMS · LHCb

Worldwide LHC Computing Grid – Tier-0

CERN & Budapest (2013-2019)

2 independent, dedicated HV lines

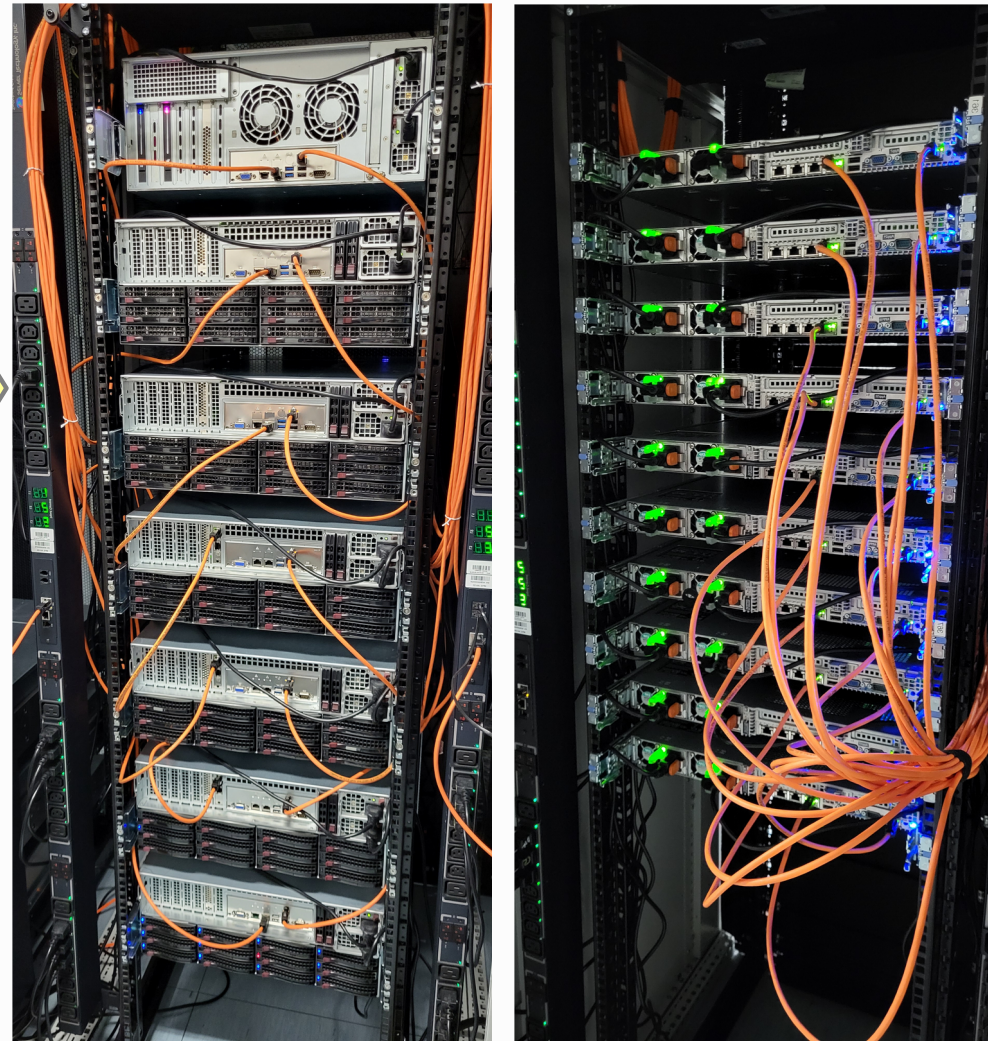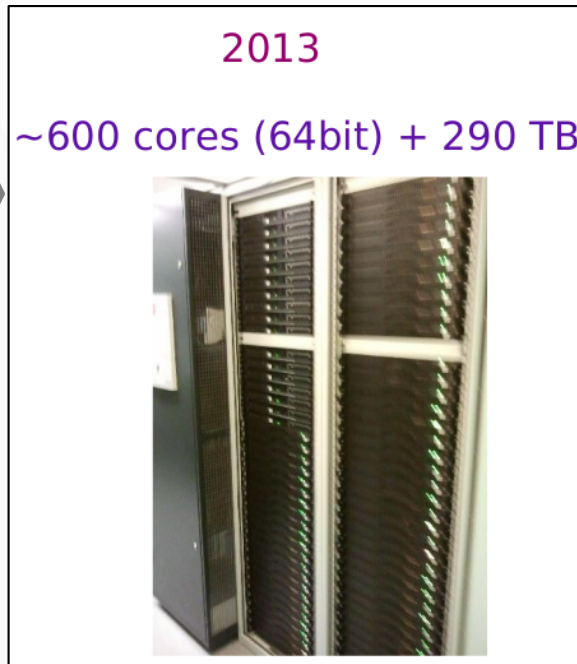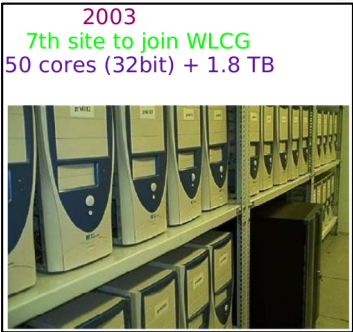Full UPS and diesel coverage for all IT load (incl. Cooling)

2 x 100 Gbps to CERN

20 000+ CPU cores, 5.5 PB+ storage

Tier-2 in Budapest

2022

2003
7th site to join WLCG
50 cores (32bit) + 1.8 TB

2013

~600 cores (64bit) + 290 TB

HEPSPEC06 hours

2018/19	79,174,223	(0.16%)
2019/20	102,751,086	(0.12%)
2020/21	217,791,152	(0.21%)
2021/22	342,439,409	(0.31%)

Since spring of 2022: at the Wigner DC

4000 cores (shared between CMS (2/3) and ALICE (1/3))

3.6 PB disk

Need to keep up ~15% yearly growth

Not only Tier-2 in Budapest

WSCLAB
WIGNER SCIENTIFIC COMPUTING LABORATORY

2022

13 years in parallel computing (Wigner GPU Laboratory) & HPC @ WDC

Brief history:

- Starting of the WLCG Grid (ALICE & CMS) Tier-2 at the Wigner
- 2005-2008 early years: idea of using GPU in HEP calculations
- 2009 Discussion with G. Barnaföldi & P. Lévai & G. Debreczeni
- 2 main direction: **HEP** & Gravity
- 2010- 1st GPU Day & formation of the Wigner GPU Laboratory
- 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**) at the Wigner Data Center

WSCLAB

WIGNER SCIENTIFIC COMPUTING LABORATORY

✓ Massively Parallel Classical- and Quantum Computing Simulations in HEP MassivPara@HEP (2020-2.1.1-ED-2021-00179)

- Massive parallel computing: Wigner_AF + GPULab + HIJING++
- Quantum Computer simulations (Maxeler FPGA)

✓ Wigner RCP & INFRA investments @2021

✓ Young Researcher's Fellowship

✓ Wigner GPU Laboratory

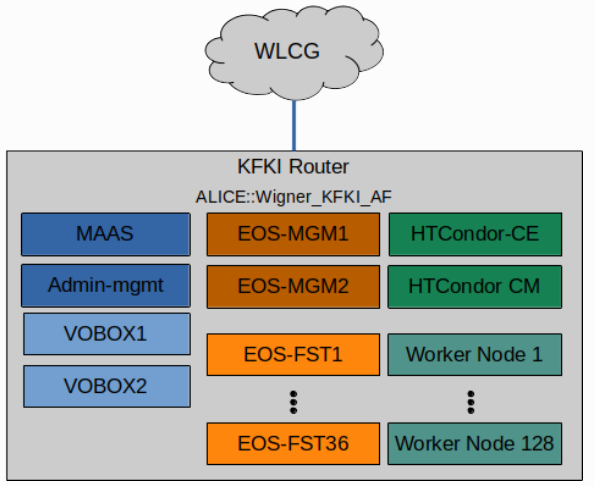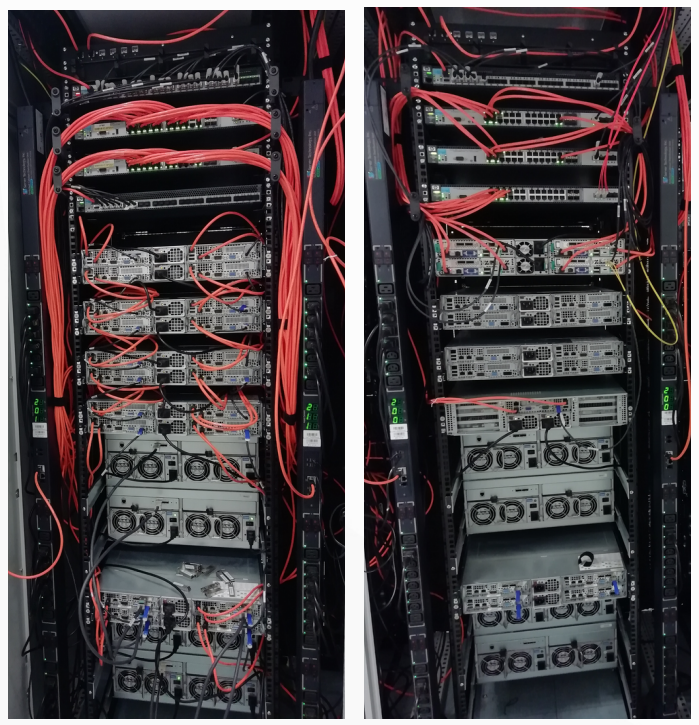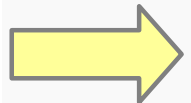✓ ALICE + CMS WLCG T2
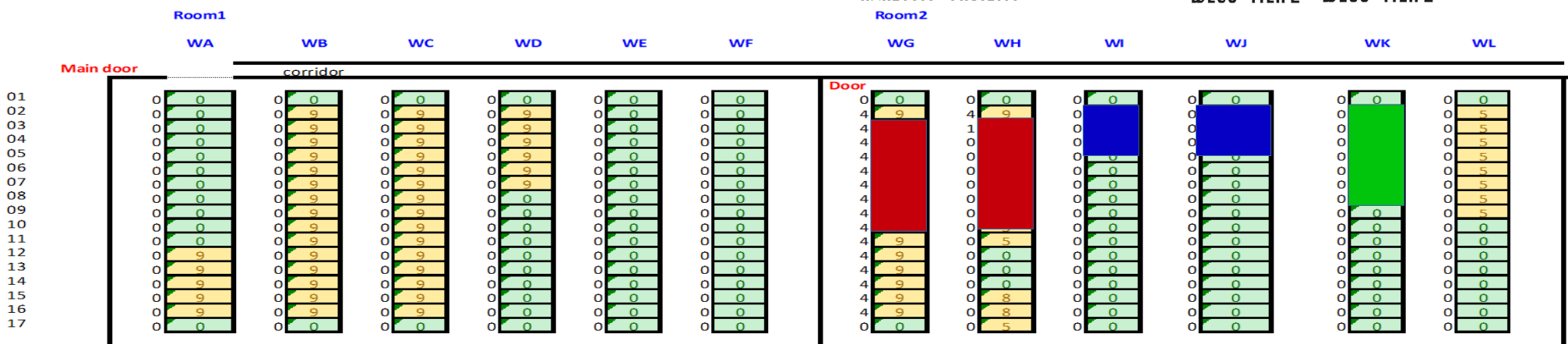
A new, specialized facility for ALICE

- **Re-utilizing the Tier-0 @ Budapest hardwares**
  - First design: 2019Q4
- **Today: 9 racks optimized for maximal data throughput**
  - SE: EOS config & monitoring
    - 2 redundant MGM nodes
    - 36 FST nodes, with 24 x 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)
    - 128 worker nodes, with 32 vCPU for each node
    - this pool is shared among the two queues, but the single-core queue has a limited number of maximum jobs

ALICE-PUBLIC-2021-007
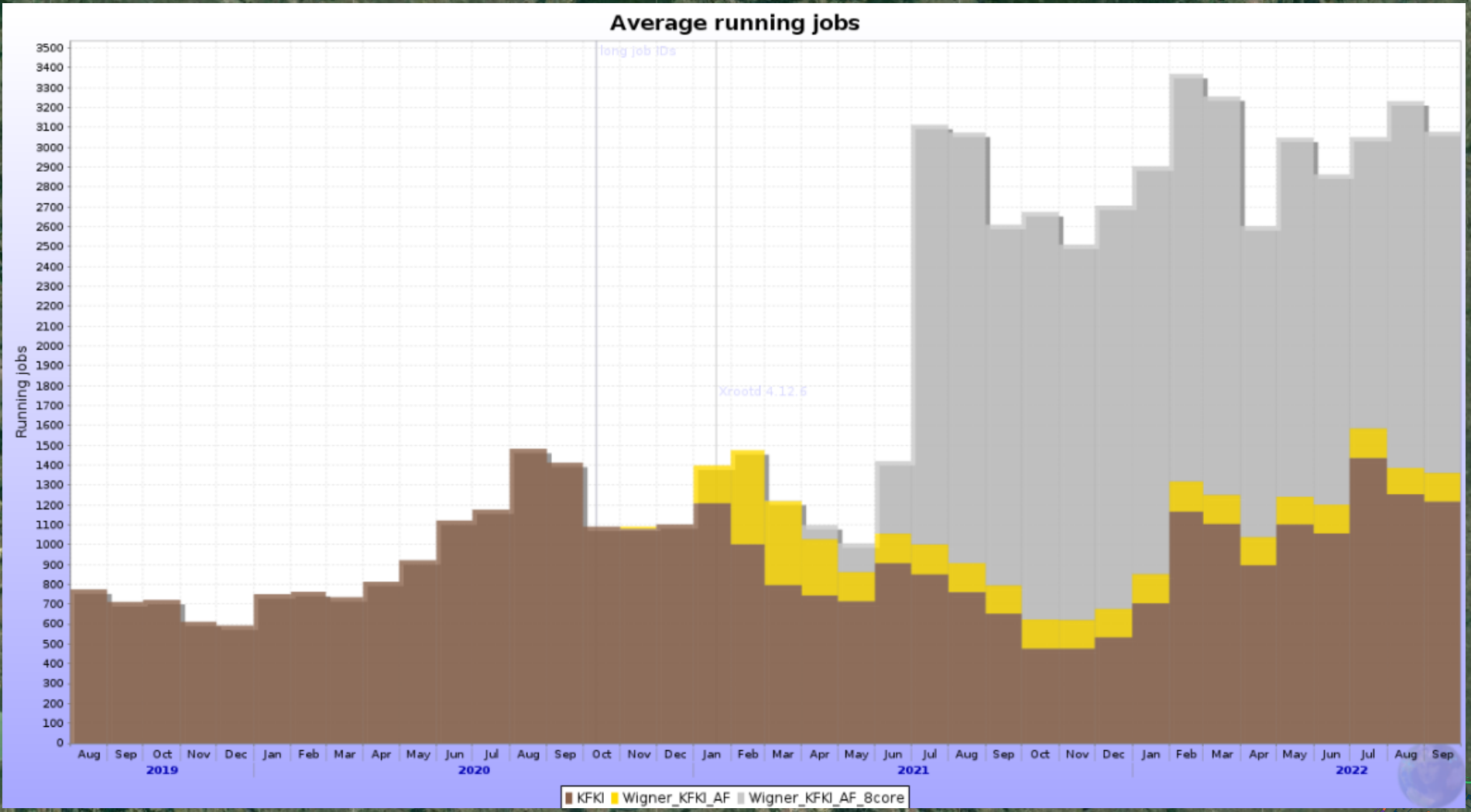
The Wigner ALICE Analysis Facility

Gábor Bíró[1,2], Gergely Gábor Barnaföldi[1], Péter Lévai[1], Latchezar Betev[3] and Jan Fiete Grosse-Oetringhaus[3]
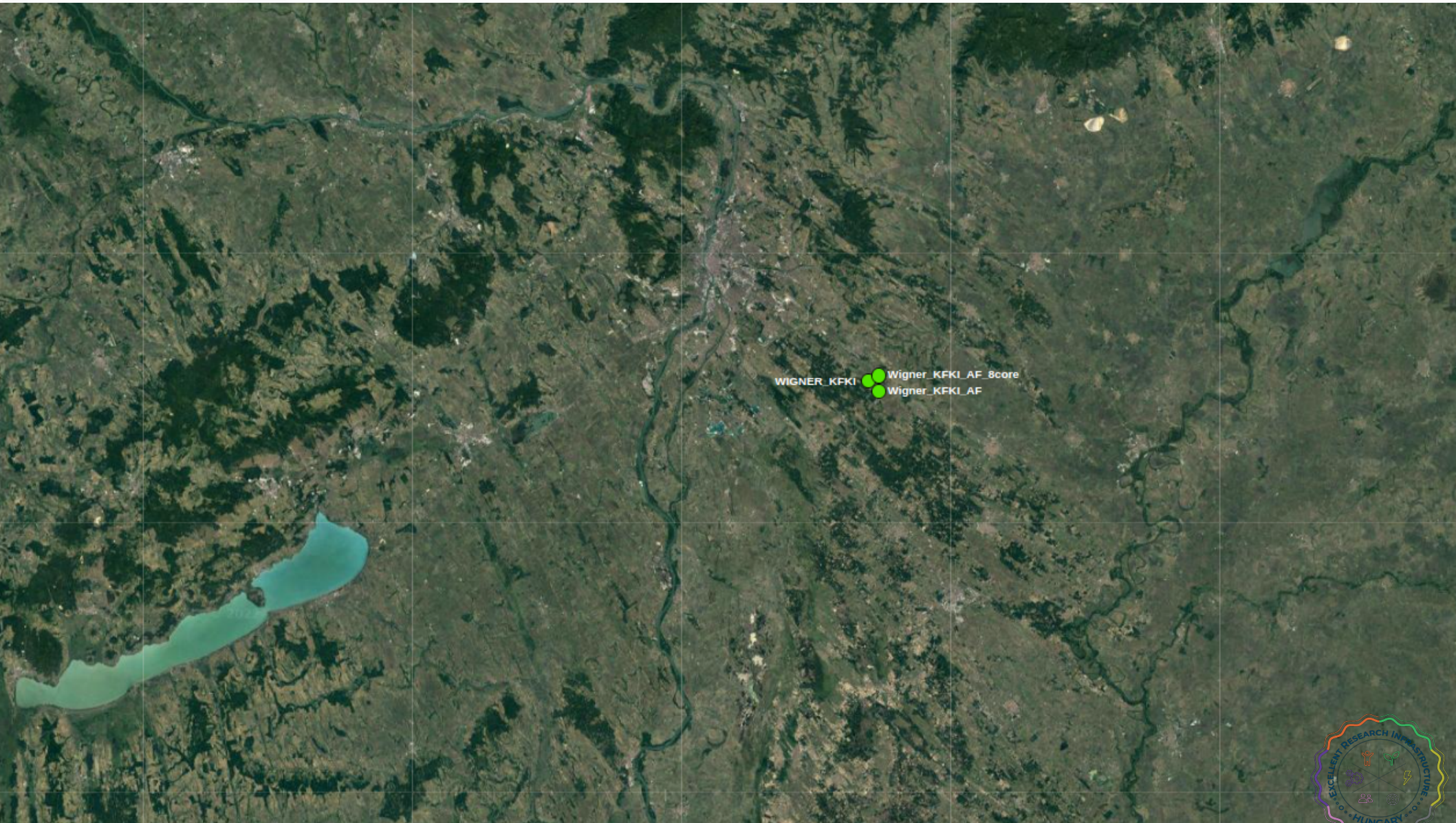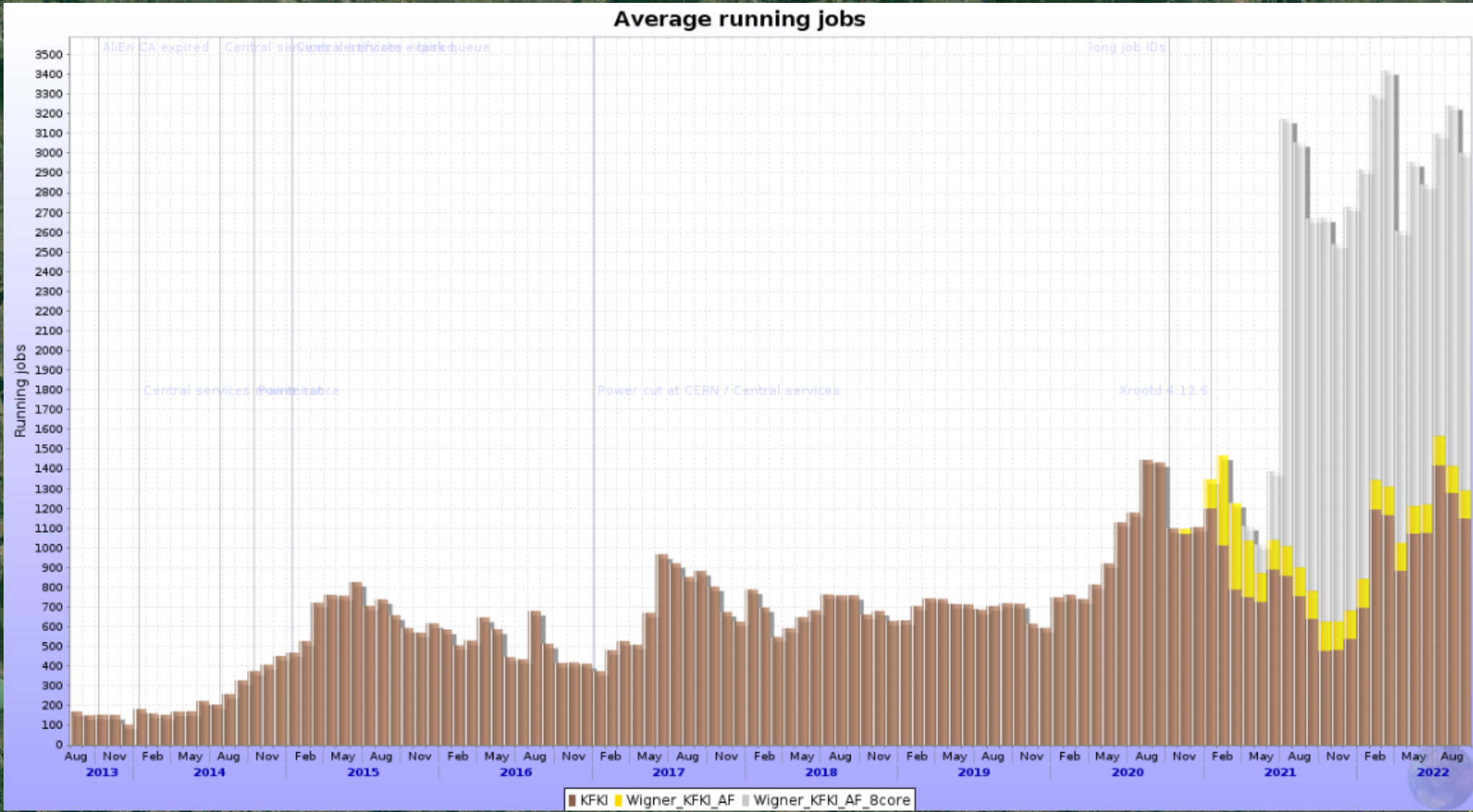
A new, specialized facility for ALICE

A new, specialized facility for ALICE

Average running jobs

A new, specialized facility for ALICE

Average running jobs

International projects(@WDC)

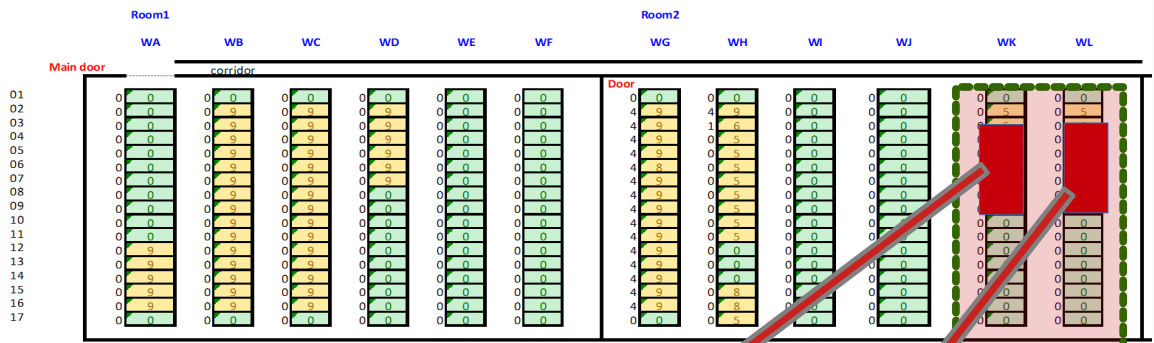- **2003-: WLCG T2 ALICE & CMS (@'21-'22: ~187k€)**

  - 4000 vCPU + 2 GB/vcore RAM

  - Usable SE capacity: 1.2 PB + 2.4 PB on disk

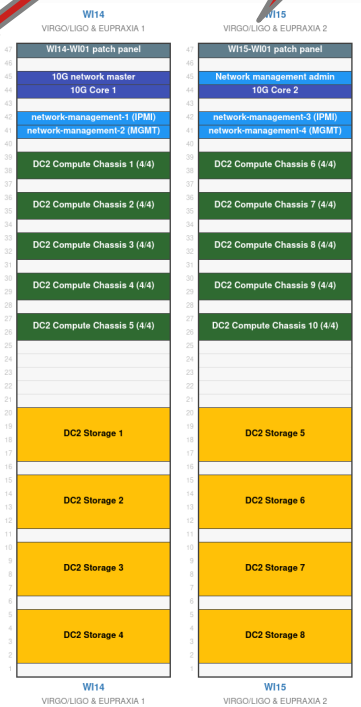 - Single- and multicore core queues

- **2022-: VIRGO & EUPRAXIA**

  - VIRGO T2 SITE

  - 1600 vCPU + 5120 TB RAM

  - Usable SE capacity: ~1.0 PB

- **Wigner RCP investment (@'21-'22: ~250k€)**

  - Nvidia 6xTesla T4 + Nvidia 8xA2

  - 20 TB local storage

  - 10G switch to GEANT (100G: **SOON**)

  - Mathematica server

  - Supermicro 8xA100

  - Maxeller 2xFPGA (Xilinx Alveo)

- Coming soon:

  - EPYC gate server

  - Infiniband switch & cards

11

Events

- **ALICE Tier-1/Tier-2 workshop (26-28. September 2022)**

    https://indico.cern.ch/event/877541/

- 6 Lectures on Modern Scientific Programming **(14-15. November 2022)**

- **12 GPU Days**

GPU Day participants (academy, industry, student):

Year			
2015	44	29	35
2016	37	31	32
2017	33	31	38
2018	42	48	30
2019	40	27	87
2020	50	23	10
2021	55	20	35
2022	43	18	31

- Regular cloud training events by the WDC

- 40 WSCLAB (Wigner GPU Lab) Fellowship (31 finished + 9 running)

- 33+ industrial & academic partners (Lombiq LTD, Ericsson, Khronos, CERN...)

- 35+ scientific publications and program codes

    https://wigner.hu/en/wsclab

    http://gpu.wigner.hu/en/home

    https://gpuday.com/

Research projects

- **HIJING++**
  - Next-gen heavy-ion Monte Carlo event generator
- **Machine learning for plasma channel profiling**
  - Monitoring tool for the AWAKE experiment
- **Modeling hadronization with Machine Learning techniques**
- **proton-CT**
  - Novel medical imaging method with ALICE-developed detectors
  - Accelerating the image reconstruction with Machine Learning
- **ALICE, CMS publications**
- **Contribution to COVID-19 research**
- **Gravitational waves**
  - Ligo/Virgo
- **High-precision calculations for nuclear reactor dynamics**
- **Collaboration Spotting**
- **QA centre for the ALICE TPC upgrade**
- **CRU development for DAQ**
- **Participation in the Quantum Technology Initiative**
  - National Quantum Technology Program
  - Dedicated grants
  - Investment on Maxeler DataFlow Machines 2022Q2
- ...

Introducing HIJING++: the Heavy Ion Monte Carlo Generator for the High-Luminosity LHC Era

Gábor Bíró[ab], Gergely Gábor Barnaföldi[b], Gábor Papp[a], Miklos Gyulassy[bcde], Péter Lévai[b], Xin-Nian Wang[cd] and Ben-Wei Zhang[c]
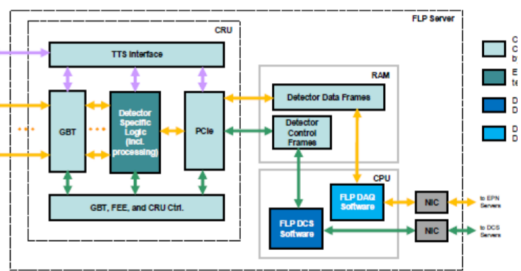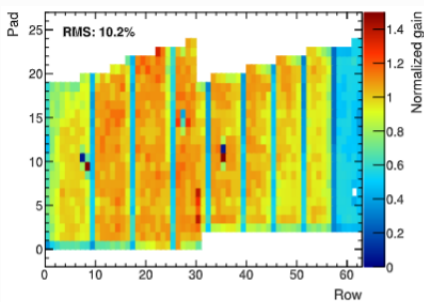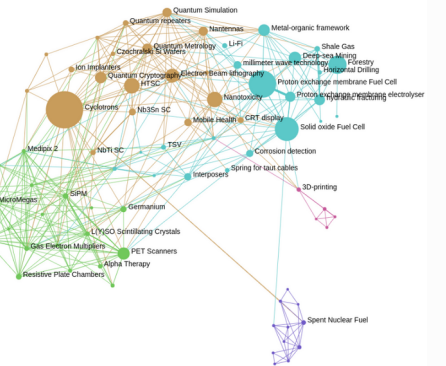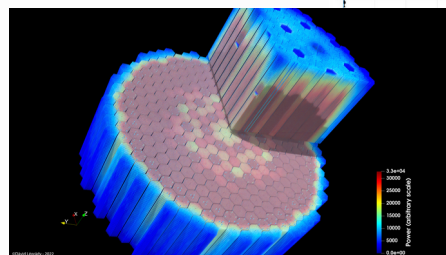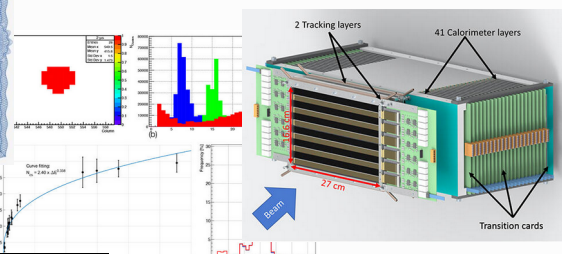
PHYSICAL REVIEW D **105**, 114022 (2022)

Estimating elliptic flow coefficient in heavy ion collisions using deep learning
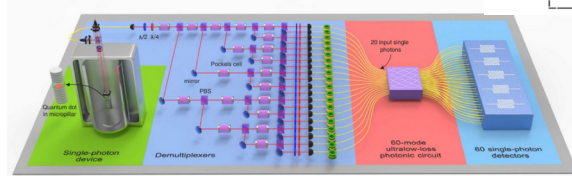
Neelkamal Mallick[1], Suraj Prasad[1], Aditya Nath Mishra[2], Raghunath Sahoo[1,3,*], and Gergely Gábor Barnaföldi[2]

Machine learning methods for Schlieren imaging of a plasma channel in tenuous atomic vapor

Gábor Bíró,[1] Mihály Pocsai,[1] Imre F. Barna,[1] Joshua T. Moody,[2] and Gábor Demeter[1]

Simulation of Photonic Quantum Computers Enhanced by Data-Flow Engines

Special Theme 📅 20 December 2021 🕐 Last Updated: 21 January 2022 👁 Hits: 1889

by Peter Rakyta (ELTE), Ágoston Kaposi, Zoltán Kolarovszki, Tamás Kozsik (ELTE), and Zoltán Zimborás (Wigner)

PHYSICAL REVIEW LETTERS **123**, 250503 (2019)

Summary

HEP computing in Hungary: **~30** technical/scientific experts

- Accumulated knowledge at the Wigner DC

- Training programs for the new generations

- Expertise and broad variety of resources you can **count on**

Difficult challenge: monotonically rising upkeep costs

THANK YOU FOR YOUR ATTENTION!