HEP computing in Serbia

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Institute of Physics Belgrade

- The first National Institute of the Republic of Serbia

- Dedicated to the study of physics and related disciplines

- Around 200 researchers

- 25 laboratories and 2 spin-off companies

- More than 100 international projects

- More than 25 EU-funded projects

PARADOX cluster

- Common name for computer equipment installed at the Institute's Scientific Computing Laboratory

- Since 2005, 5 major upgrades

- High-Performance Computing

- High-Throughput Computing

- High-Performance Data Analysis

- Artificial Intelligence

High-Performance Computing

- PARADOX-V

  - 1536 CPU-cores in total

  - 64 CPU-cores/node, 128 GB RAM/node

  - 91 TB storage (144 TB total)

  - Infiniband 100 Gbps

- PARADOX-IV

  - 1696 CPU-cores in total

  - 16 CPU-cores/node, 32 GB RAM/node

  - 66 TB storage (98 TB total)

  - Infiniband 40 Gbps

High-Throughput Computing

- PARADOX-III
  - 704 CPU-cores in total
  - 8 CPU-cores/node, 16 GB RAM/node
  - 64 TB storage
- NGI AEGIS
  - Grid-core services
  - 9 Grid sites

High-Performance Data Analysis

- Hadoop-based data analysis cluster

  - 60 CPU cores

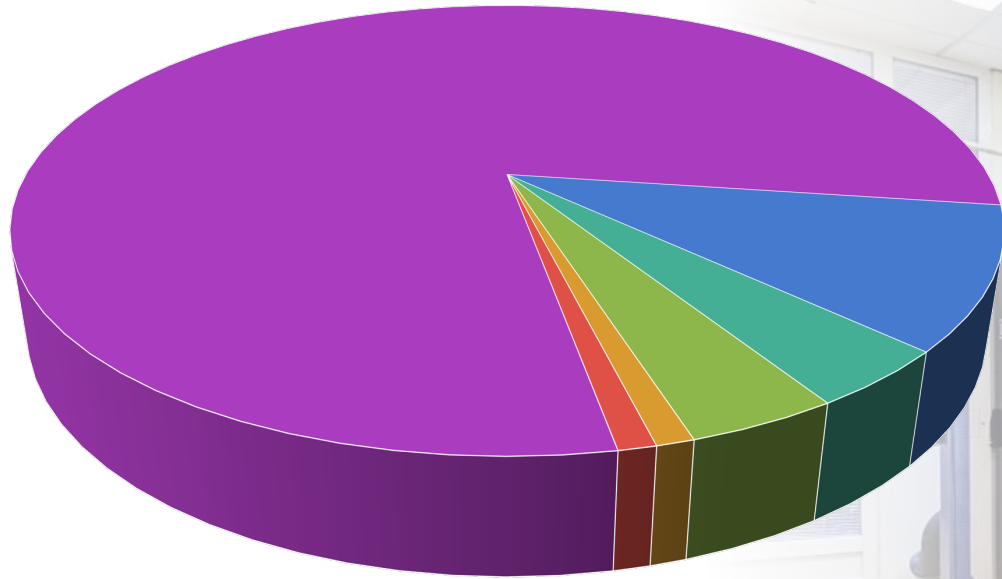 - 180 GB of RAM

  - 5.3 TB of storage in HDFS

Artificial Intelligence

- Hadoop-based data analysis cluster

  - NVIDIA A30 Tensor Core GPU

Usage of the PARADOX cluster

- Major scientific communities

- Computational physics
- Climatology
- Computer science
- Computational chemistry
- Astrophysics
- Other

- Collaboration with SMEs

R&D of ML-based algorithms @ HEP

- **ML@FPGAs & HLS4ML, optimization tools:**
  - ML@FPGAs: Allows for fast inference with FPGAs on massive quantities of data.
  - HLS4ML: Development of tool(s) to optimize FPGA firmware design for deep-learning inference (performance, resource usage, latency)
  - Development of tools for ML on-demand service and tools for optimizing ML training on large scale distributed heterogeneous computing resources

- **Particle identification, energy regression, event classification:**
  - Development for HGCAL: clustering algorithms, CNNs for FPGA @ L1
  - Development of DNN support @FPGA for L1/HLT level

Impact (@ CERN, HEP and beyond):

- Coordination/contribution in key R&D project(s), including coordination of effort to integrate the R&D and tools in CERN IT infrastructure
- Several papers published in high-impact international journals and presented at four international conferences
- R&D important for non-LHC experiments (DUNE, sPHENIX, IceCube), as well as in the other domains/industries (IT, automotive, and medical)

Quantum Computing

- Collaboration with QuEra

- MIT-based startup

- Neutral atoms setup

- First applications in condensed matter physics, other areas expected to follow

Perspective

- Serbia became the EuroHPC member in 2022

- Part of a consortium for the DAEDALUS supercomputer setup

- Part of a consortium for AI factory setup

- 15 years of collaboration in the region (SEEREN, SEE-GRID, HP-SEE, VI-SEEM, NI4OS-Europe)

- Member of the EOSC association (Skills4EOSC, EOSC Beyond)

Thank you!