



“GOVORUN” supercomputer for JINR tasks

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Meshcheryakov Laboratory of Information Technologies

Рабочее совещание “ОИЯИ-ВШЭ”

14 June 2024

PCK

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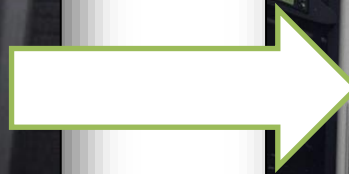
$$\Gamma_{\mu\nu} = O_{\mu}^{\alpha} O_{\nu}^{\beta}$$
$$m_{\mu} = m_{\nu} \exp\left(\frac{2\pi i}{\hbar} \int_{\mu}^{\nu} \psi d\tau\right)$$
$$L = -m_{\nu} c^2 \sqrt{1 - \frac{v^2}{c^2}}$$
$$W_{\mu} = \left(\frac{1}{2} m_{\nu} v^2 - \frac{1}{2} m_{\nu} v^4 \right)$$
$$W_{\nu} = \left(\frac{1}{2} m_{\nu} v^2 + \frac{1}{2} m_{\nu} v^4 \right)$$
$$L = -m_{\nu} c^2 \sqrt{1 - \frac{v^2}{c^2}}$$
$$W_{\mu} = \left(\frac{1}{2} m_{\nu} v^2 - \frac{1}{2} m_{\nu} v^4 \right)$$
$$W_{\nu} = \left(\frac{1}{2} m_{\nu} v^2 + \frac{1}{2} m_{\nu} v^4 \right)$$



Development of the heterogeneous HybriLIT platform



Cluster HybriLIT 2014:
Full peak performance:
140 TFlops for single precision;
50 TFlops for double precision



#18 в Top50

“Govorun” supercomputer
First stage **2018:**
Full peak performance :
1 PFlops for single precision
500 TFlops for double precision
9th in the current edition of the
IO500 list (July 2018)



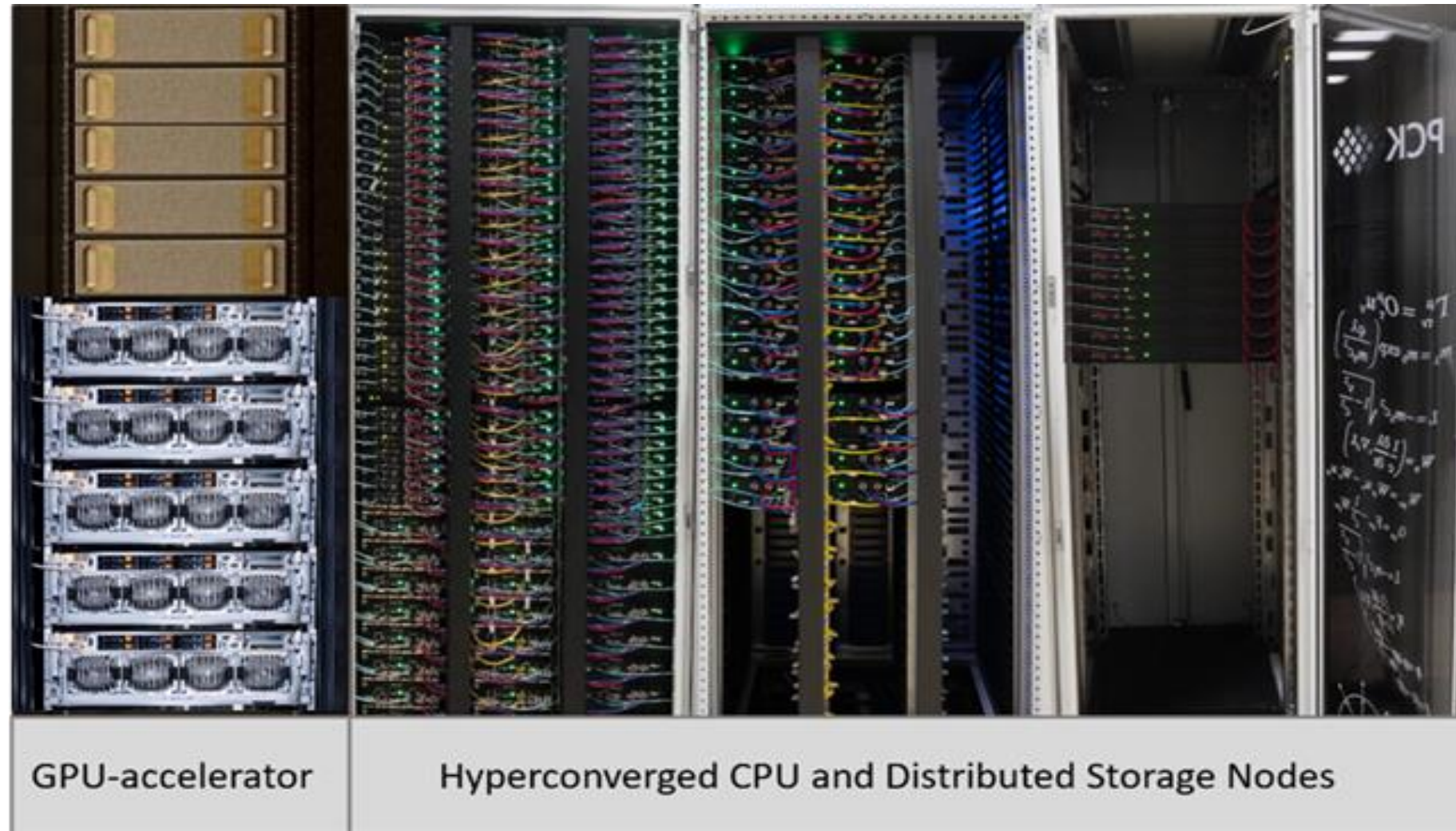
#10 в Top50

“Govorun” supercomputer
Second stage **2019:**
Full peak performance :
1.7 PFlops for single precision
860 TFlops for double precision
288 TB CCXD with I/O speed **>300 Gb/s**
17th in the current edition of the **IO500**
list (July 2020)



Russian DC Awards 2020 in
“The Best IT Solution for
Data Centers”

"Govorun" supercomputer



GPU-accelerator

Hyperconverged CPU and Distributed Storage Nodes

Current status:

**163 hyperconverged
compute CPU nodes**
80 GPU accelerators

Total peak performance:

1.7 PFlops DP
3.4 PFlops SP

Total capacity of Hierarchical Storage:

8.6 PB

Data IO rate: 300 Gb/s

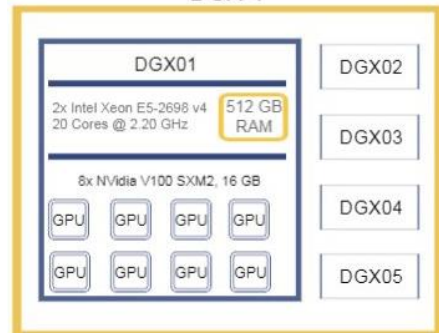
The GPU-component of the "Govorun" Supercomputer



2017

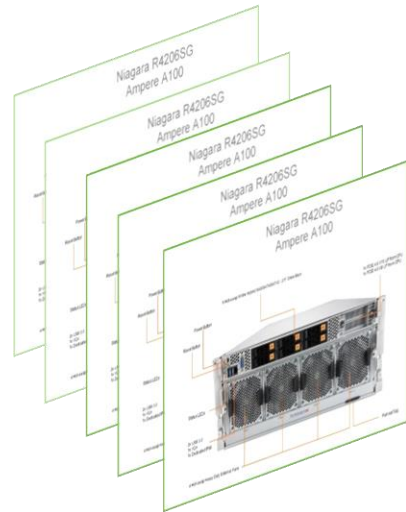


DGX-1

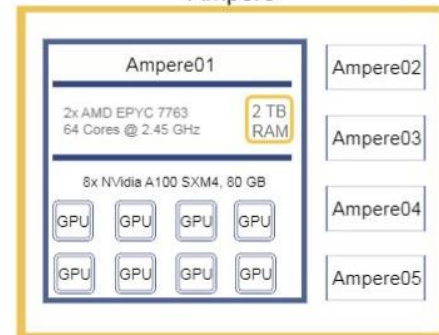


40 NVIDIA V100

2023



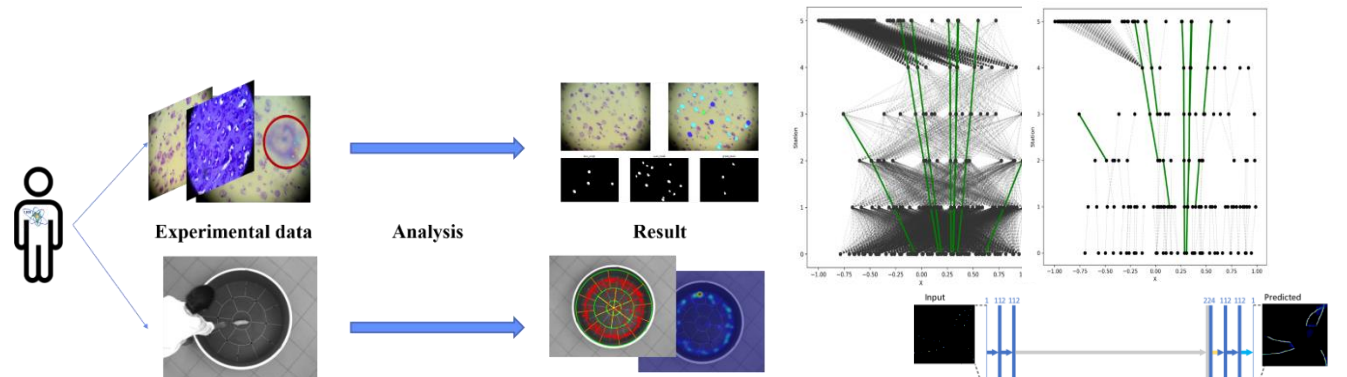
Ampere



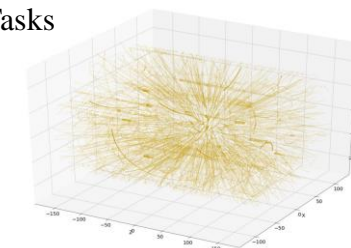
40 NVIDIA A100

Total peak performance of the GPU-component:
900 Tflops for Double-Precision computations
26 Pflops for Half-Precision computations

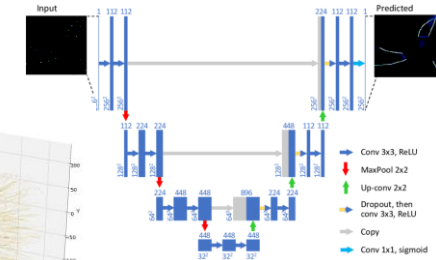
The GPU-component gives a users of the supercomputer a possibility to use machine learning and deep learning algorithms for solving applied problems by neural network approach: process data from experiments at LRB in the frame of the Information System for radiation biology tasks; experimental data processing and analysis at the NICA accelerator complex and ect.



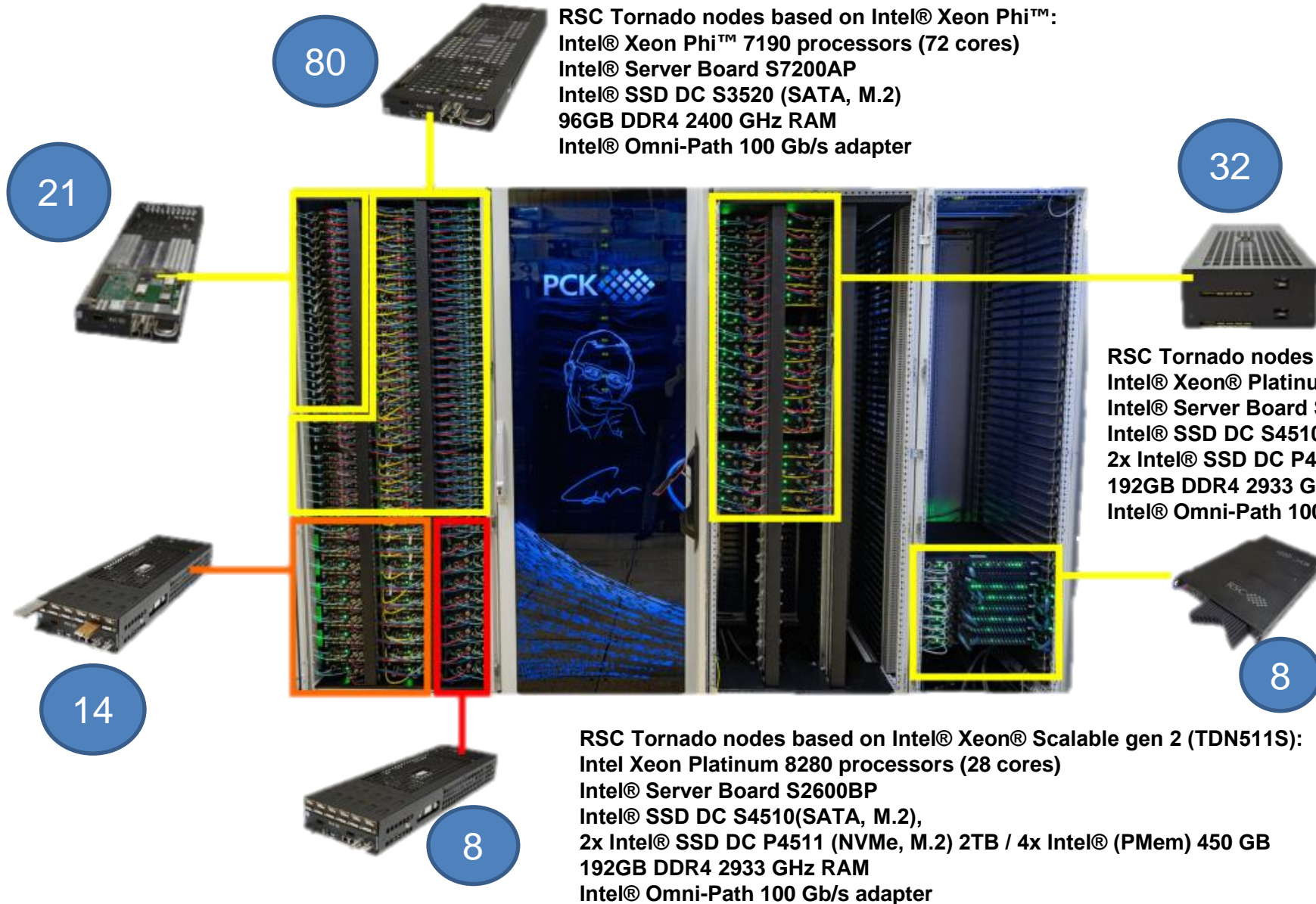
Information System for Radiation Biology Tasks



Data Processing and Analysis



The CPU-component of the "Govorun" Supercomputer



RSC Tornado nodes based on Intel® Xeon Phi™:
Intel® Xeon Phi™ 7190 processors (72 cores)
Intel® Server Board S7200AP
Intel® SSD DC S3520 (SATA, M.2)
96GB DDR4 2400 GHz RAM
Intel® Omni-Path 100 Gb/s adapter

RSC Tornado nodes based on Intel® Xeon® Scalable gen 3 (TDN511):
Intel® Xeon® Platinum 8268 processors (24 cores)
Intel® Server Board S2600BP
Intel® SSD DC S4510(SATA, M.2),
2x Intel® SSD DC P4511 (NVMe, M.2) 2TB
192GB DDR4 2933 GHz RAM
Intel® Omni-Path 100 Gb/s adapter

RSC Tornado nodes based on Intel® Xeon® Scalable gen 2 (TDN511S):
Intel Xeon Platinum 8280 processors (28 cores)
Intel® Server Board S2600BP
Intel® SSD DC S4510(SATA, M.2),
2x Intel® SSD DC P4511 (NVMe, M.2) 2TB / 4x Intel® (PMem) 450 GB
192GB DDR4 2933 GHz RAM
Intel® Omni-Path 100 Gb/s adapter

Current status:

163 hyperconverged compute CPU nodes

8552 compute cores

Total peak performance:
800 TFlops Double-Precision computations

Total capacity of Hierarchical Storage: **8.6 PB**

Data IO rate: **300 Gb/s**

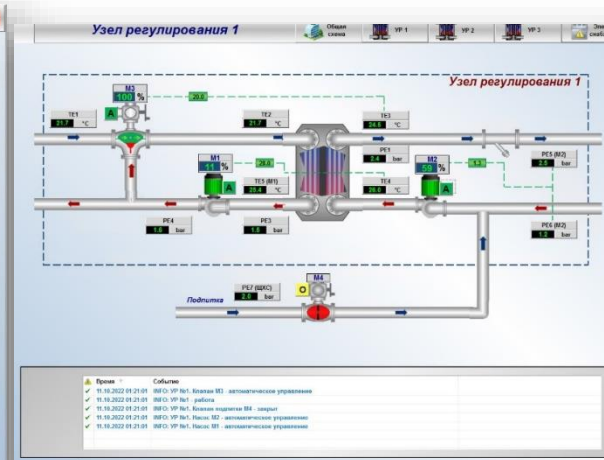
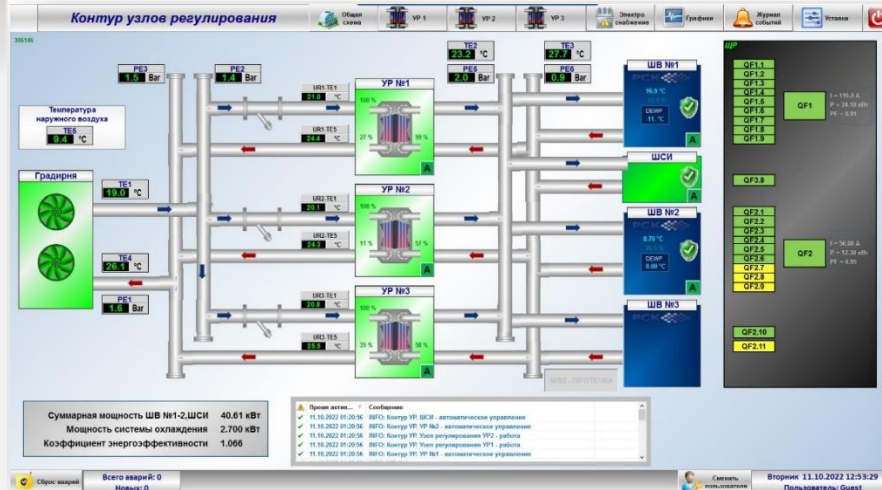
Supercomputer "Govorun". Hot water cooling.



PUE ~ 1,06

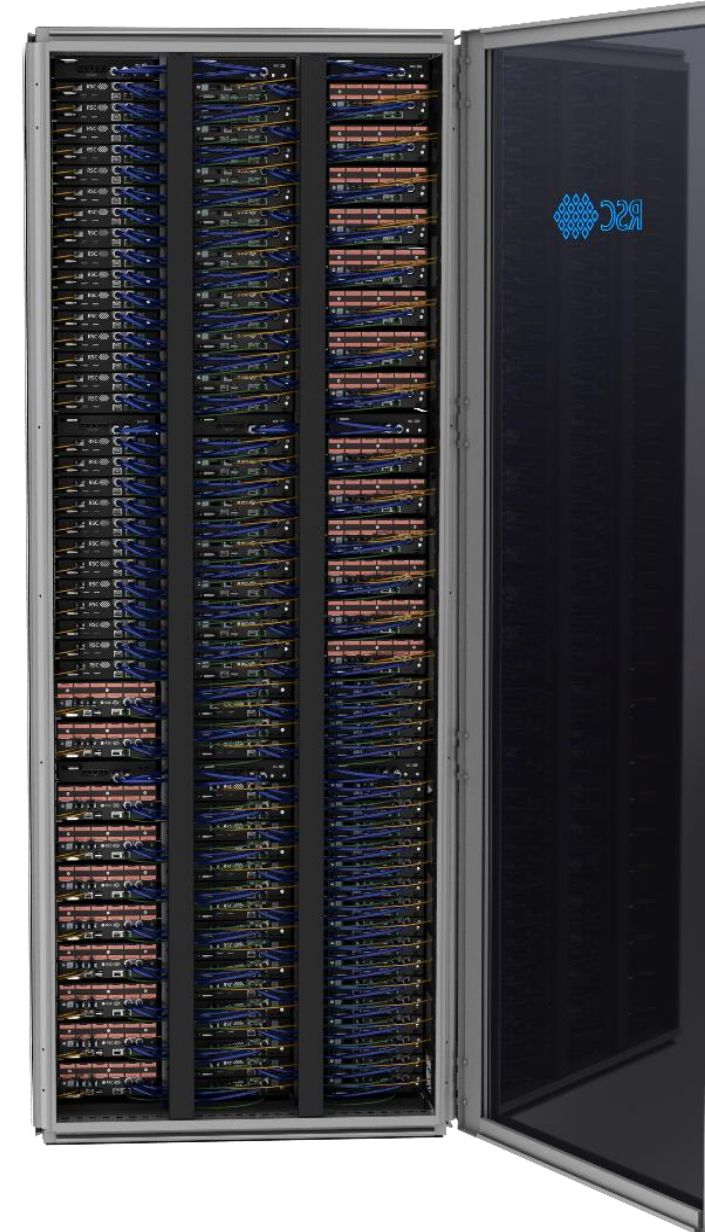
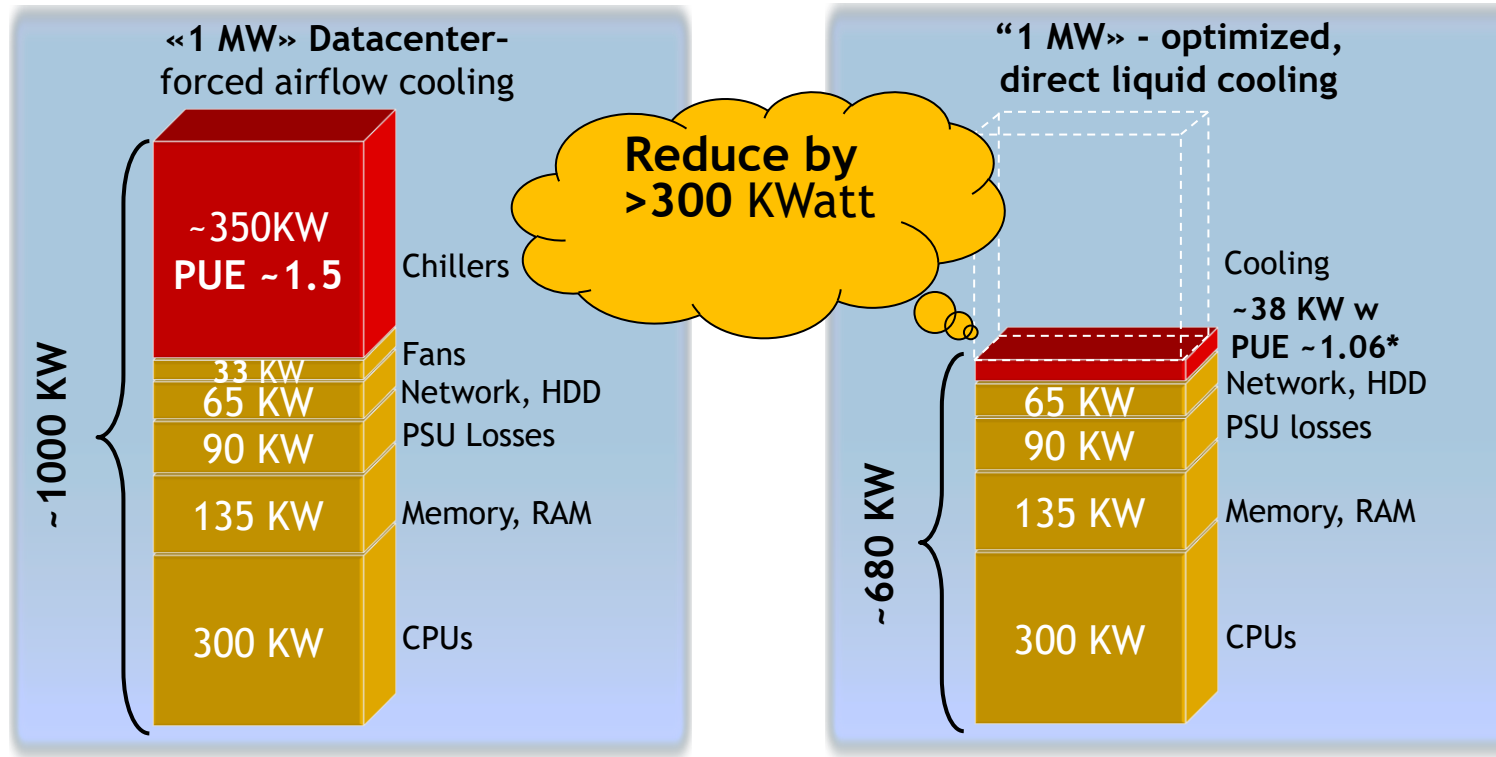
Power usage effectiveness

The supercomputer receives water cooled to a temperature of **45 degrees**. Having passed through the entire circuit in the supercomputer, water heated to **50 degrees** returns to the heat exchanger, where it is cooled, transferring thermal energy to the hydraulic circuit of the dry cooling tower.



The cooling system has a smooth performance adjustment, which allows you to increase or decrease the power of the cooling system in accordance with the actual load. This allows you to significantly reduce energy consumption at partial load.

Reason for liquid cooling: 1MW datacenter example



Cooling is a major optimization option in datacenter

Additional benefits:

- 1) Compact design enabled
- 2) Top bin CPU even in dense blade package
- 3) More reliability

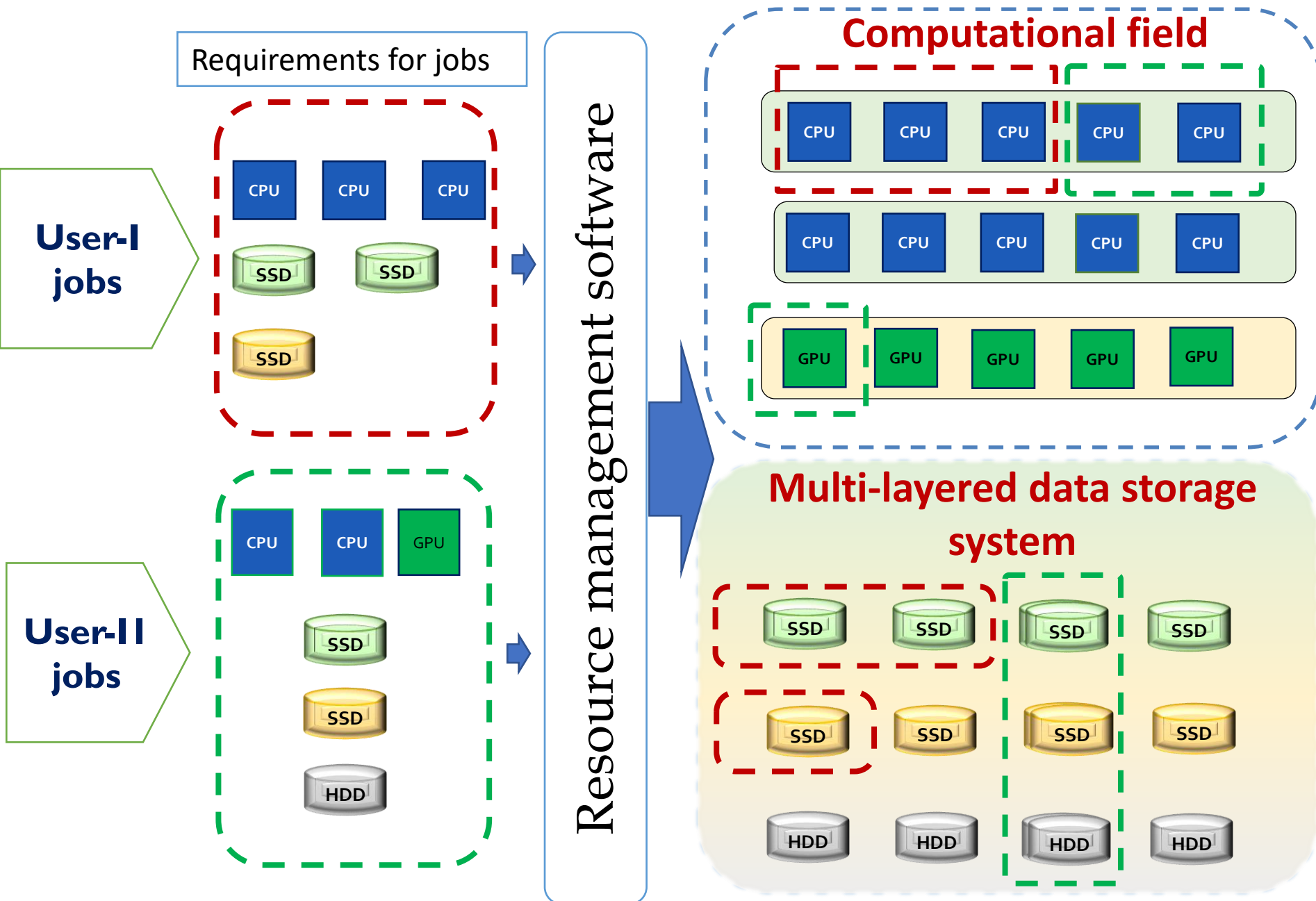
Liquid cooling for supercomputers



Top500 Rank	System	Cooling technology
1	Frontier	Direct cold water cooling
2	Fugaku	Direct cold water cooling
3	LUMI	Direct cold water cooling
4	Leonardo	Direct warm water cooling
5	Summit	Direct cold water cooling
6	Sierra	Direct cold water cooling
7	Sunway TaihuLight	Airflow cooling
8	Perlmutter	Direct cold water cooling
9	Selene	Airflow cooling
10	Tianhe-2A	Airflow cooling

Top500 Rank	System	Cooling technology
11	Explorerer-WUS3	Airflow cooling
12	Adastra	Direct cold water cooling
13	JUWELS Booster Module	Direct warm water cooling
14	Pre-Eos 128 Node DGX SuperPOD	Direct cold water cooling
15	HPC5	Airflow cooling
16	Voyager-EUS2	Airflow cooling
17	Setonix – GPU	Direct cold water cooling
18	Discovery 5	Direct cold water cooling
19	Polaris	Airflow cooling
20	SSC-21	Airflow cooling

Liquid cooking systems take **12 positions** among the first 20 places in the list of the Top500 most productive supercomputers in the world.



The "Govorun" supercomputer has unique properties for the flexibility of customizing the user's job.

For his job the user can allocate the required number and type of computing nodes and the required volume and type of data storage systems.

This property enables the effective solution of different tasks, which makes the "Govorun" supercomputer a unique tool for research underway at JINR.

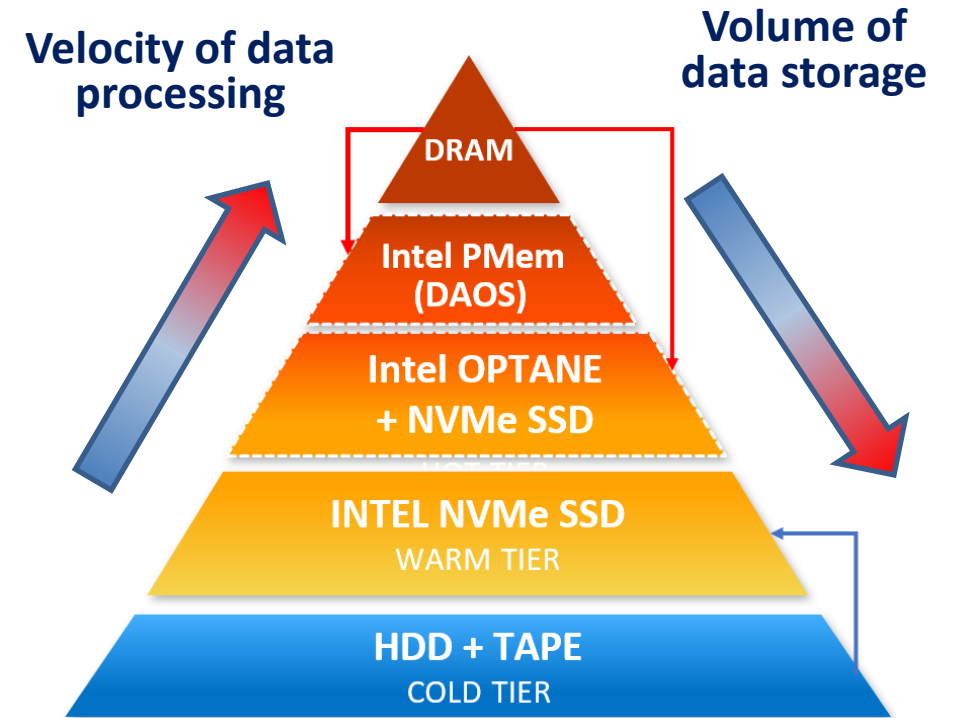
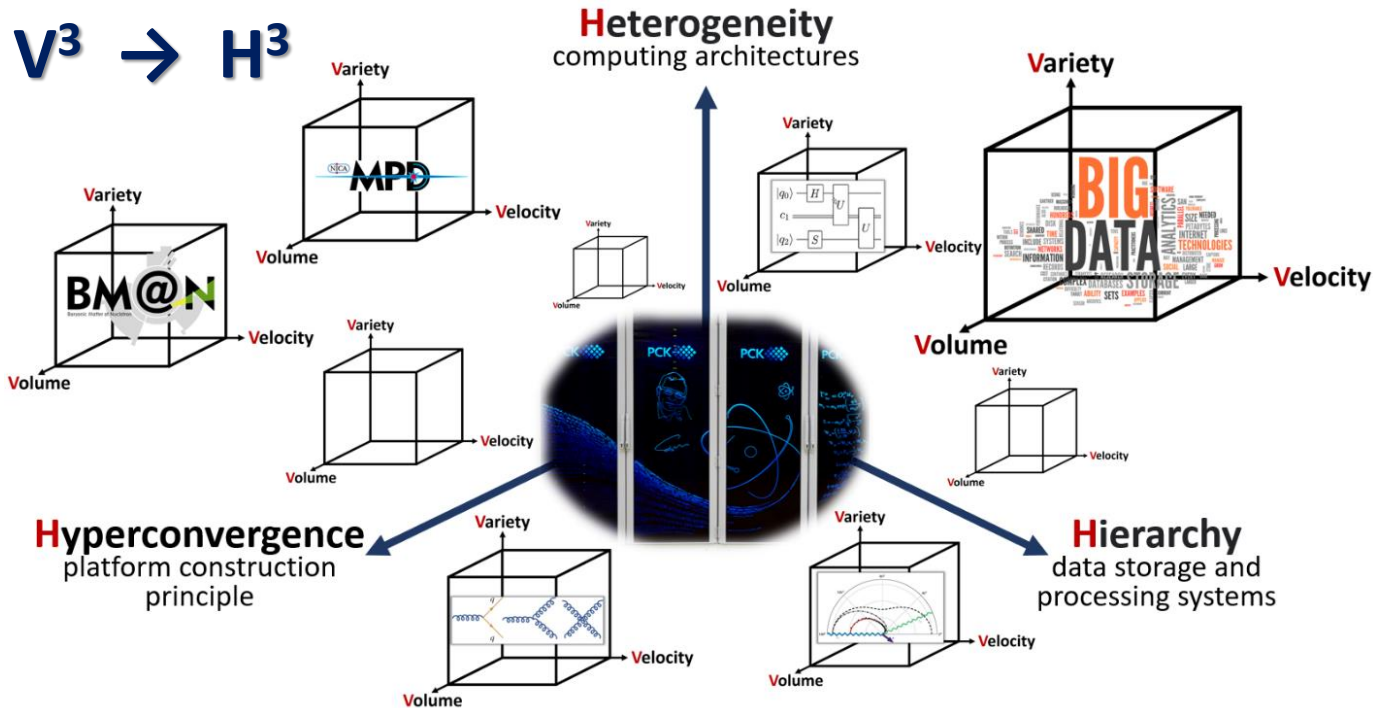
Big Data on the "Govorun" Supercomputer for NICA megaproject



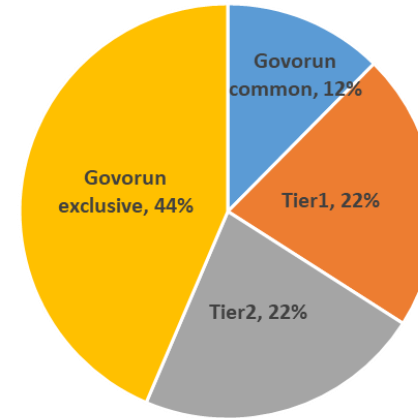
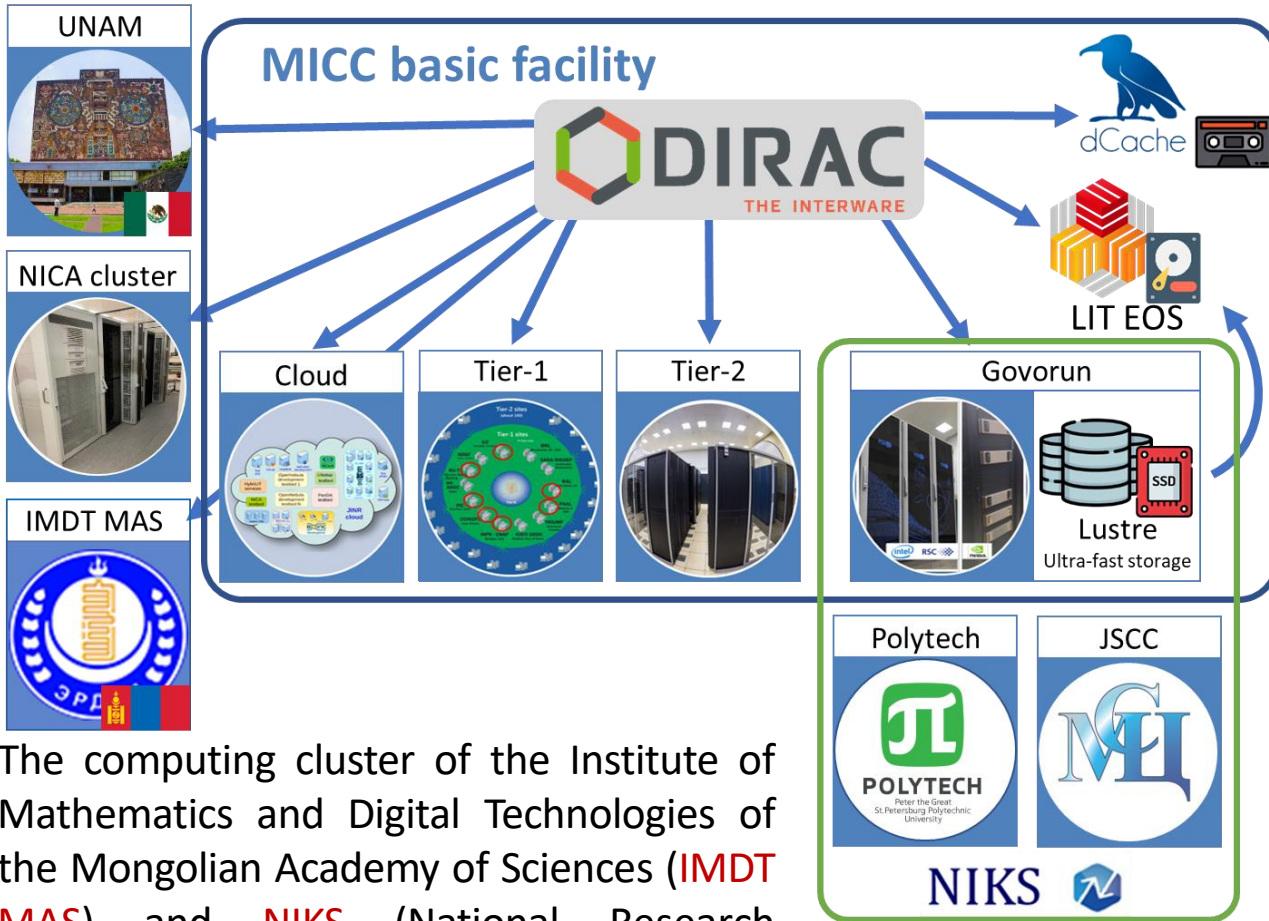
The DAOS polygon of the "Govorun" supercomputer takes the **1st** place among Russian supercomputers in terms of the data processing rate in the current **IO500 list**.

Heterogeneity
Hierarchy
Hyperconvergence → provide → **Variety**
Velocity
Volume

$V^3 \rightarrow H^3$

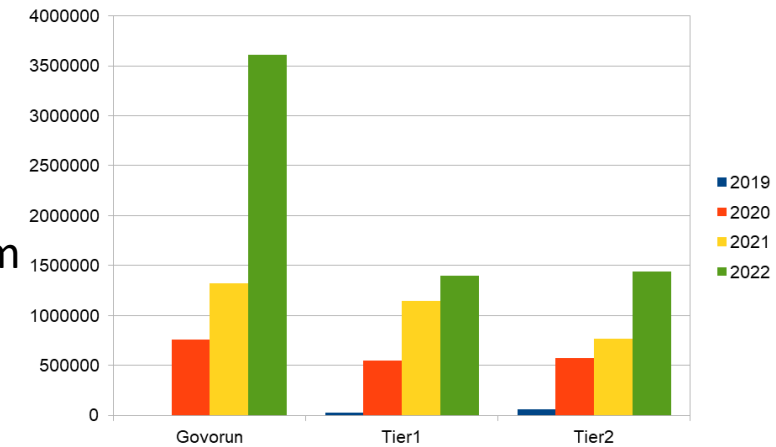


Heterogeneous distributed computing environment



Share of the use of different MICC components for MPD tasks in 2022: the SC "Govorun" resources are the **most efficient** for MPD tasks.

Increase in the share of the MICC computing resources on the DIRAC platform in normalized CPU HEP-SPEC06 days



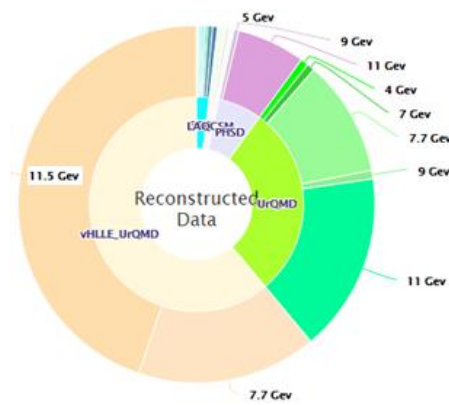
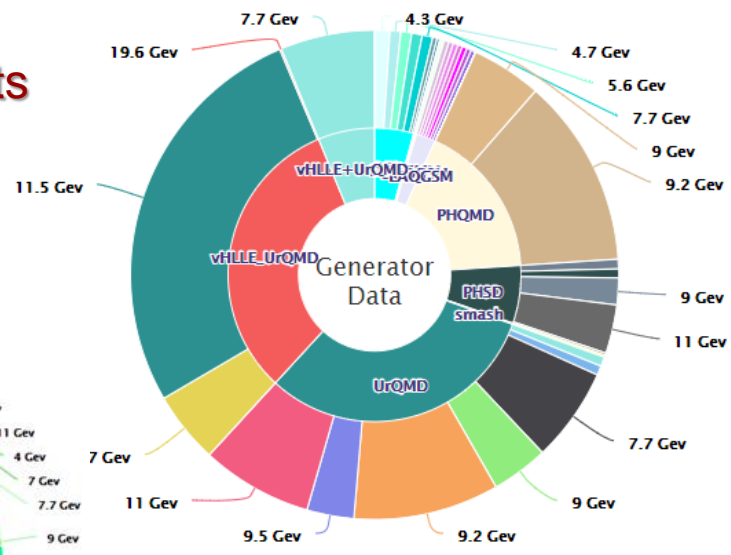
The computing cluster of the Institute of Mathematics and Digital Technologies of the Mongolian Academy of Sciences (**IMDT MAS**) and **NIKS** (National Research Computer Network, the Russia's largest research and education network) **were integrated into the heterogeneous distributed environment based on the DIRAC platform.**

Summary statistics of using the DIRAC platform for MPD tasks in 2019-2022



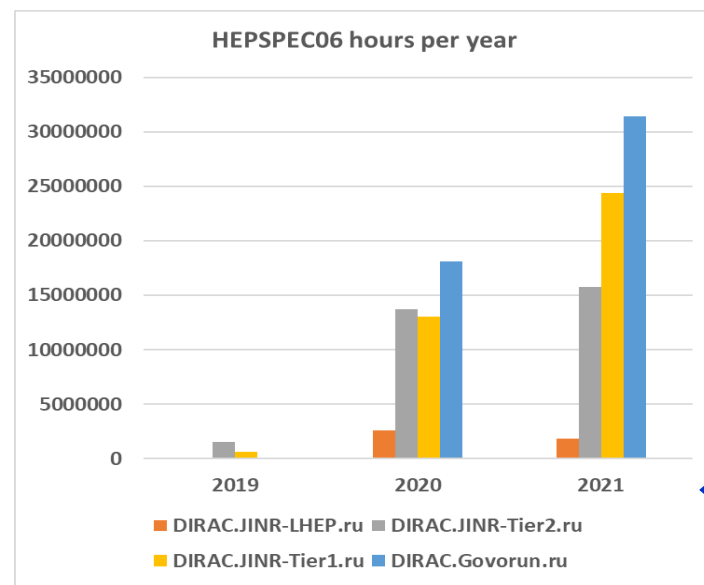
Heterogeneous distributed computing environment for the MPD experiment

✓ **1200 * 10⁶ events** were generated using *UrQMD*, *PHQMD*, *PHSD* and other models



✓ **392 * 10⁶ events** were reconstructed

“Govorun” up to **40%**

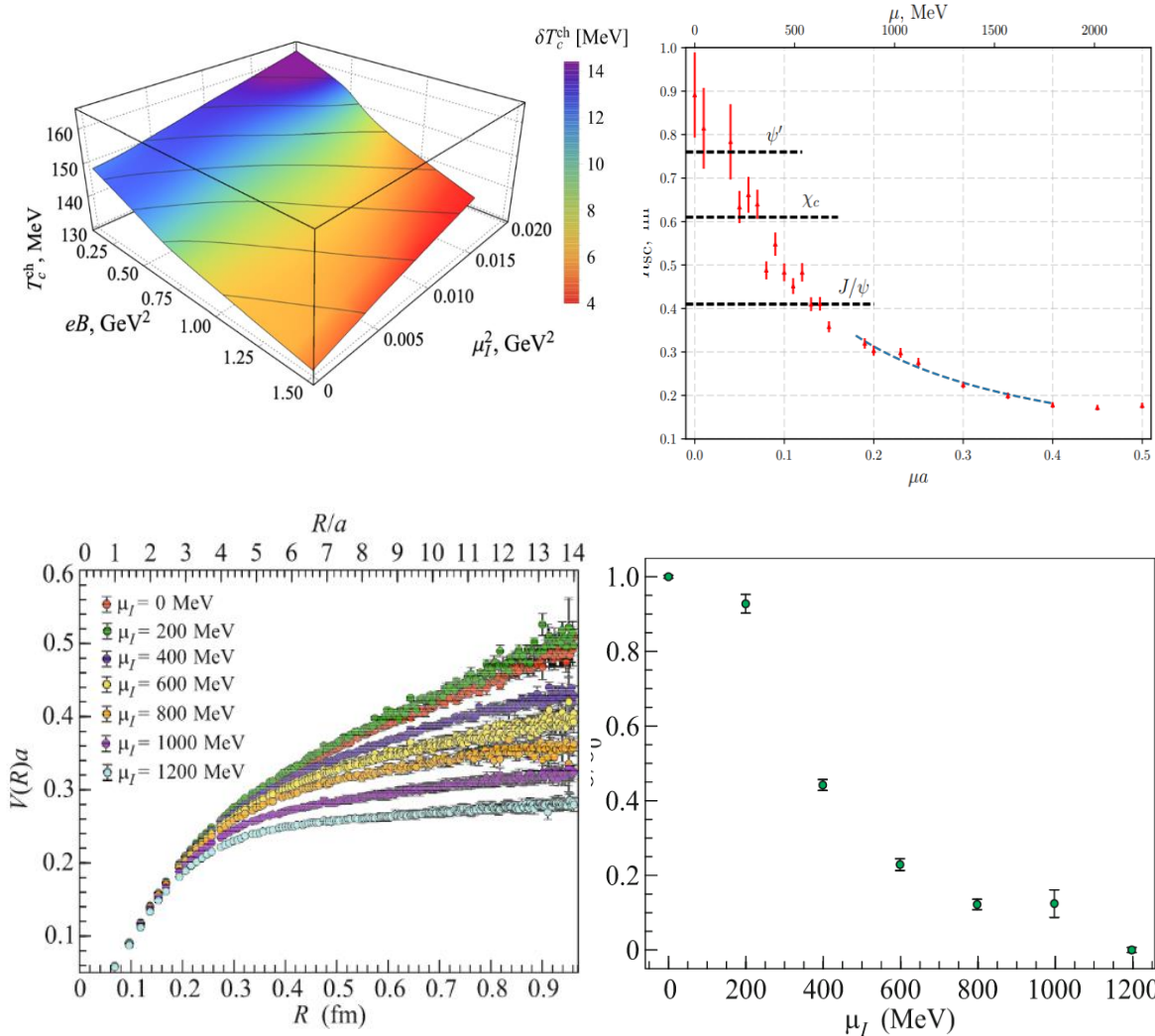


Available resources of the DIRAC platform for the MPD experiment:

- “Govorun” supercomputer: up to **1,586** cores in the latest production
- Tier1: **920** cores
- Tier2: **1,000** cores
- Clouds (JINR and JINR Member States): **70** cores
- NICA offline cluster: **300** cores (limit for users)
- UNAM (Mexico University): **100** cores
- National Research Computer Network of Russia (NIKS, now resources from SPBTU and JSCC): **672** cores – New resource, added in 12.2021.

The mass production **storages** integrated into the Dirac File Catalog are **1.5 PB** in size.

The histogram illustrates the accounting data from the centers. The metric shown is Sum CPU Work, grouped by center and year.



The resources of the “Govorun” supercomputer were used to study the properties of quantum chromodynamics (QCD) and Dirac semimetals in a tight-binding mode under extreme external conditions using lattice modeling. The given study entails the inversion of large matrices, which is performed on video cards (GPU), as well as massive parallel CPU calculations, to implement the quantum Monte-Carlo method:

- The influence of the magnetic field on the confinement/deconfinement transition and the chiral transition at finite temperature and zero baryon density were investigated using the numerical modeling of lattice QCD with a physical quark mass.
- Quantum chromodynamics with non-zero isospin density taking into account dynamical u- d-, s- quarks in the Kogut-Susskind formulation was studied.
- The potential of the interaction between a static quark-antiquark pair in dense two-color QCD was investigated, and the confinement/deconfinement phenomenon was studied.
- The effect of the non-zero chiral chemical potential on dynamical chiral symmetry breaking for Dirac semimetals was studied.
- The influence of the external magnetic field on the electromagnetic conductivity of quark-gluon plasma was investigated.

The results are published in the articles:

1. V. V. Braguta, M. N. Chernodub, A. Yu. Kotov, A. V. Molochkov, and A. A. Nikolaev, Phys. Rev. D 100 (2019), 114503, DOI: 10.1103/PhysRevD.100.114503, arXiv:1909.09547
2. V.V. Braguta , A.Yu. Kotov, A.A. Nikolaev, JETP Lett. 110 (2019) no.1, 1-4, DOI: 10.1134/S0021364019130083 (JETP Letters, 110 (2019) no.1, 3-6)
3. N. Astrakhantsev, V. Bornyakov, V. Braguta, E.M. Ilgenfritz, A.Y. Kotov, A. Nikolaev, A. Rothkopf, PoS Confinement2018 (2019), 154, DOI: 10.22323/1.336.0154
4. V. V. Braguta, M. I. Katsnelson, A. Yu. Kotov, and A. M. Trunin, Phys.Rev. B100 (2019), 085117, DOI: 10.1103/PhysRevB.100.085117 , e-Print: arXiv:1904.07003
5. N. Yu. Astrakhantsev, V. G. Bornyakov, V. V. Braguta, E.-M. Ilgenfritz, A. Yu. Kotov, A. A. Nikolaev, A. Rothkopf, JHEP 1905 (2019) 171, DOI: 10.1007/JHEP05(2019)171,e-Print: arXiv:1808.06466
6. <https://arxiv.org/abs/1902.09325>
7. <http://arxiv.org/abs/1910.08516>

“Govorun” supercomputer for nuclear physics tasks



Study of the structure of light exotic, heavy and superheavy nuclei and reactions with them.

Simulations and data processing for the experiments with exotic nuclei

Relativistic molecular and periodic quantum-chemical calculation of superheavy elements and their compounds

Study of changes in the Periodic Law in the region of extremely heavy elements. Study of the electronic structure of elements at the end of the 7th and beginning of the 8th periods.

Study of radiation safety of heavy ion accelerators at FLNR JINR using Monte Carlo simulation

Modeling the radiation environment of the DC-140 accelerator complex using the FLUKA software package

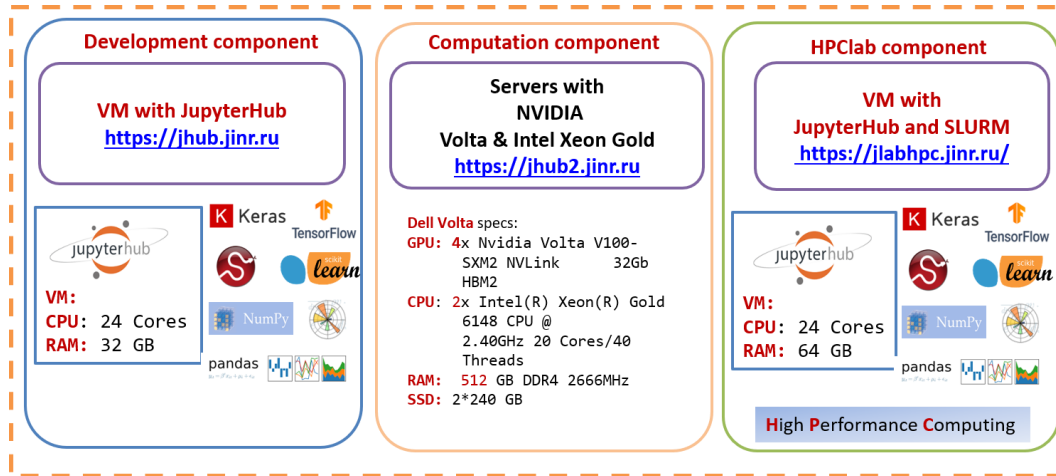
Modeling the kinetics of excitation and relaxation of dielectrics irradiated by fast heavy ions

For calculations of electronic properties of superheavy elements, an on-demand computing system was created. It containing **380 physical cores** (760 logical cores) and **80 TB** file storage managed by the NFS file system. Intensive calculations were carried out on this system using AMS, DIRAC, KANTBP, etc. software. During the past year, over **11,800 tasks** were solved, on which over **3,800,000 core hours** were spent.

The results are presented in the next publications:

- 1) Kotov A. A., Kozhedub Y. S., Glazov D. A., Ilias M., Pershina V., Shabaev V. M. // ChemPhysChem. 2023. No 24. C. E202200680;
- 2) Ryzhkov A., Pershina V., Ilias M. and Shabaev V. // Phys. Chem. Chem. Phys. 2023. No 25. C. 15362;
- 3) Savelyev I. M., Kaygorodov M. Y., Kozhedub Y. S., Malyshev A. V., Tupitsyn I.I., Shabaev V. M. // Phys. Rev. A. 2023. No 107. C. 042803;
- 4) Zaytsev V. A., Groshev M. E., Maltsev I. A., Durova A. V., Shabaev V. M. // Int. J. Quant. Chem. 2023. C. e27232.

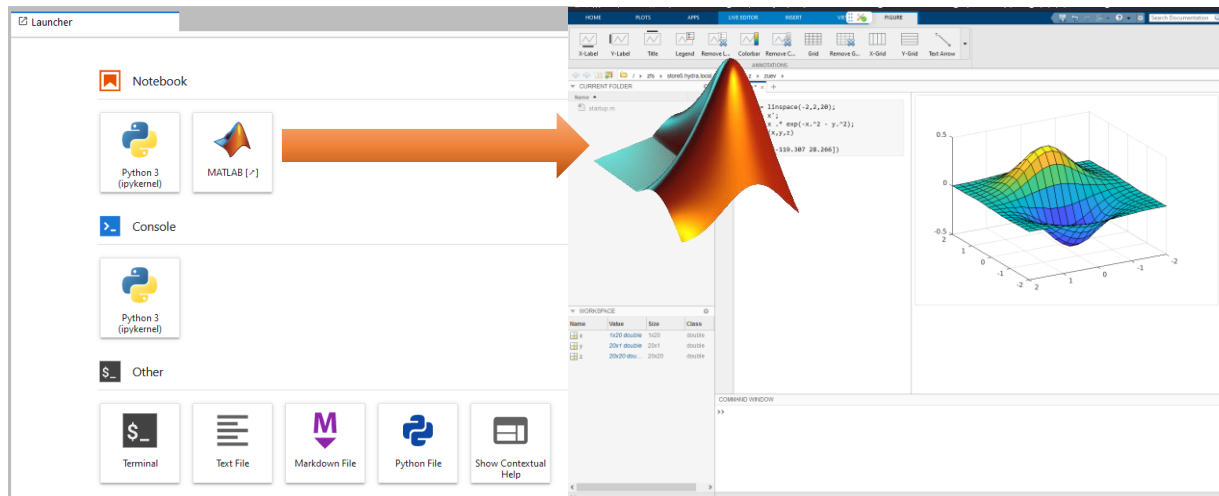
ML/DL/HPC Ecosystem of the HybriLIT Heterogeneous Platform: New Opportunities for Applied Research



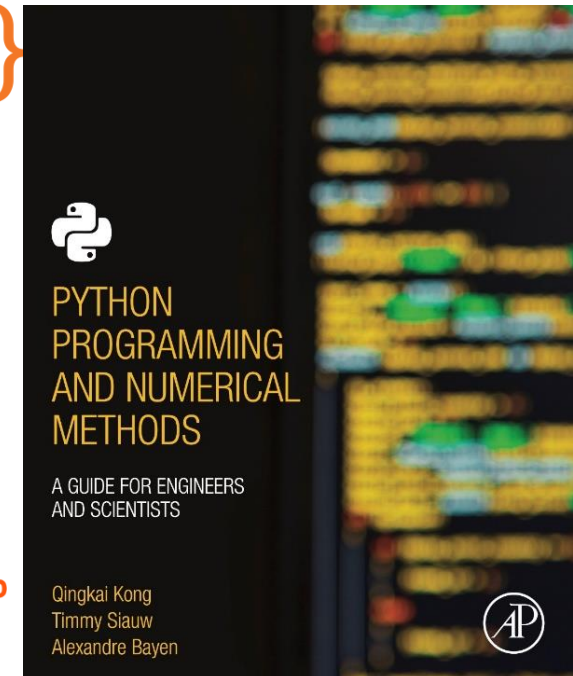
The **ML/DL/HPC ecosystem** is now actively used for machine and deep learning tasks. At the same time, the accumulated tools and libraries can be more widely used for scientific research, including:

- numerical computations;
- parallel computing on CPUs and GPUs;
- visualization of results;
- accompanying them with the necessary formulas and explanations.

In 2022, on the ML/DL/HPC ecosystem, it became possible to run the **MATLAB code in Jupyter Notebook**, which allows one to effectively perform applied and scientific computations.



Python Numerical Methods





BIOHLIT information system for radiobiological studies



dashboard

About The Open field

Open field

ЛАБОРАТОРИЯ ИНФОРМАЦИОННЫХ ТЕХНОЛОГИЙ имени М.Г. Мещерякова

This app is Open Source dashboard.

Site of MLIT JINR: [Link](#).

the project is being created within the framework of the ML/DL/HPC ecosystem of the HybriLIT platform. Link: [here](#).

hYBRI LIT/JINR

Original file

openfield.mp4

dashboard

About

Morris water tracking

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Dataset: BIOHLIT service: [Link](#).

hYBRI LIT/JINR

Анализ с кадра: 15

Траектория строится с 15 кадра

MOUSE TRACK ANALYSIS DASHBOARD

Morris water maze

Upload file

Drag and drop file here
Limit: 200MB per file • MP4, MOV, AVI

Browse files

rat4 12-32-20.avi 1.9MB

752 488 39

dashboard

About

Morris water tracking

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hYBRI LIT/JINR

Анализ с кадра: 15

Траектория строится с 15 кадра

The information system allows one to store, quickly access and process data using a stack of neural network and classical algorithms of computer vision, providing a wide range of possibilities for automating routine tasks. It gives an increase in productivity, quality and speed of

Траектория obtaining results.

dashboard

About

Morris water tracking

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Видео файл для проверки правильности построенной траектории

Запись видеофайла с FPS = 30

The current FPS is 30

dashboard

About

Morris water tracking

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dashboard

About The Open field

Open field

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The Open field test-system analysis

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Количество кадров = 500
(500, 1024, 1280)

Analyse

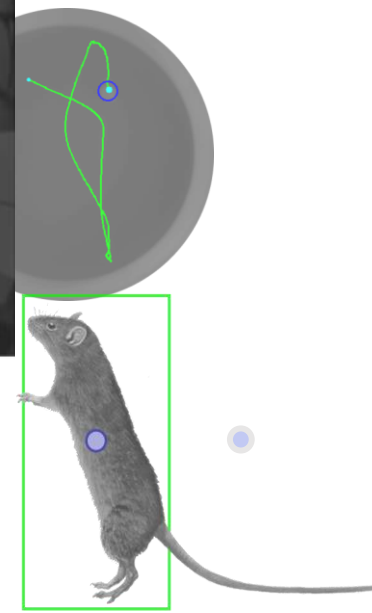
heatmap and trajectory:

Heatmap

Trajectory

Download heatmap

Download trajectory



Study the dynamics of magnetization in a Phi-0 Josephson Junction



The dynamics of the magnetic moment M of the system under consideration is described by the Landau-Lifshitz-Gilbert equation:

$$\frac{dm_x}{dt} = -\frac{1}{1 + M^2 \alpha^2} \{m_y H_z - m_z H_y + \alpha [m_x (M, H) - H_x]\},$$

$$\frac{dm_y}{dt} = -\frac{1}{1 + M^2 \alpha^2} \{m_z H_x - m_x H_z + \alpha [m_y (M, H) - H_y]\}$$

$$\frac{dm_z}{dt} = -\frac{1}{1 + M^2 \alpha^2} \{m_x H_y - m_y H_x + \alpha [m_z (M, H) - H_z]\},$$

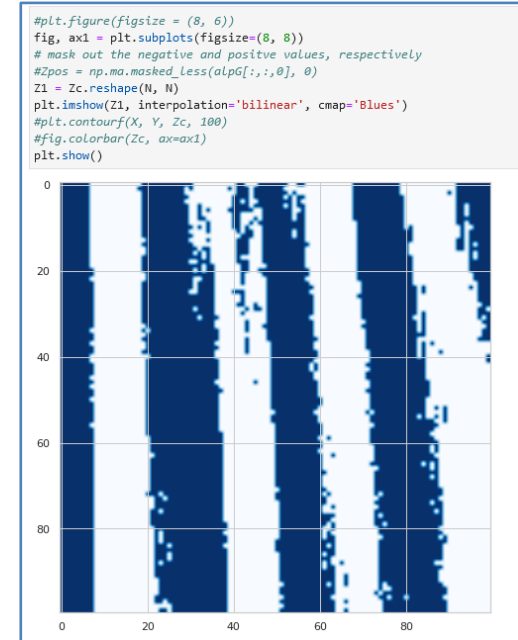
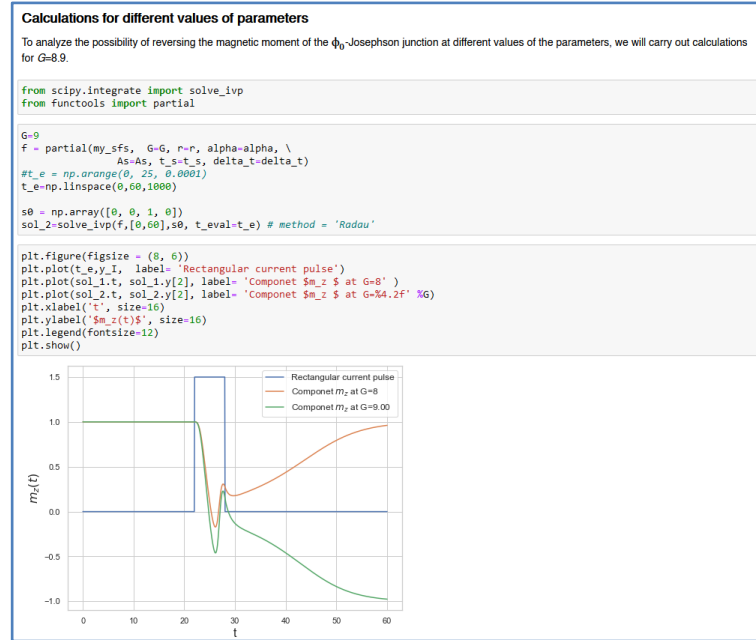
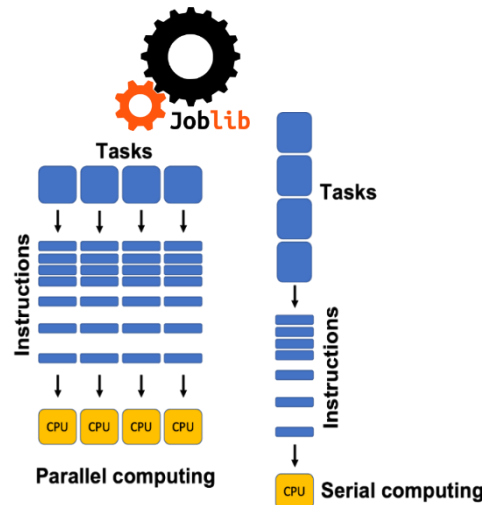
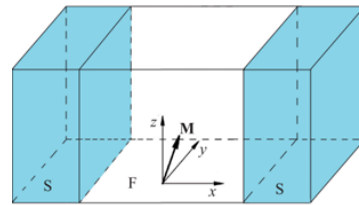
$M = [m_x, m_y, m_z]$ are the magnetic moment components; the effective field components $H = [H_x, H_y, H_z]$ depend on the Josephson phase difference ϕ and are defined as follows:

$$H_x(t) = 0,$$

$$H_y = Gr \sin(\phi(t) - tm_y(t)),$$

$$H_z(t) = m_z(t).$$

The equation for the Josephson phase difference $\phi(t)$ is determined from the equation for the electric current I flowing through the Josephson junction, measured in units of the critical current I_c :

$$\frac{d\phi}{dt} = -\frac{1}{w} \left(\sin(\phi - rm_y) + r \frac{dm_y}{dt} \right) + \frac{1}{w} I,$$


Define a function called by each process

```

from joblib import Parallel, delayed
import numpy as np

def funk_parallel(k):
    i=k//N
    j=k//N
    m_z_sol=0
    G=G0*delta_G*1
    alpha=alpha0*delta_alpha*j
    f = partial(my_sfs, G=G, r=r, alpha=alpha, \
                As=As, t_s=t_s, delta_t=delta_t)
    t_e = np.linspace(0, 60, 1000)
    s0 = np.array([0, 0, 1, 0])
    sol = solve_ivp(f, [0, 60], s0, t_eval=t_e) # method = 'Radau'
    if sol[1, :][2] < 0:
        m_z_sol = -1
        # alpGxy[i+j*N, 2] -= 1
    return m_z_sol
    
```

Serial mode calculation

```

t0 = time.time()
rez = Parallel(n_jobs=1)\
      (delayed(funk_parallel)(k) for k in range(N*N))
t1 = time.time()
print(f'Execution time (t1 - t0) s')
    
```

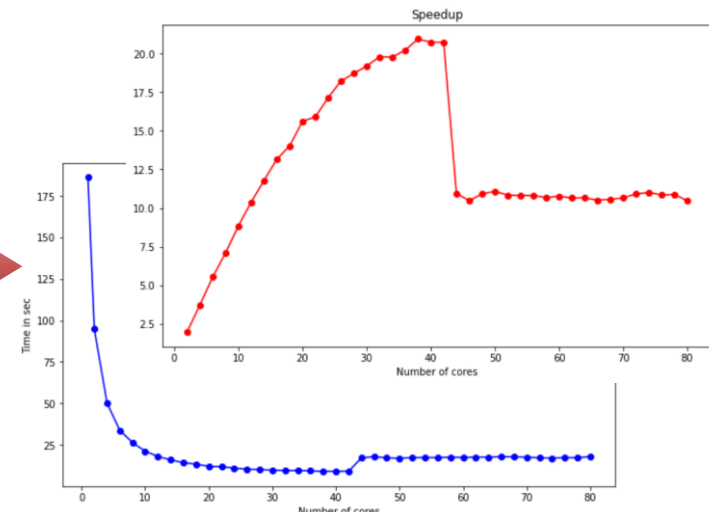
Execution time 159.9254457950592 s

Computing in Parallel Mode

```

t0 = time.time()
rez = Parallel(n_jobs=6)\
      (delayed(funk_parallel)(k) for k in range(N*N))
t1 = time.time()
print(f'Execution time (t1 - t0) s')
    
```

Execution time 34.51503801345825 s



Quantum polygon



Notebook

Python 3 (ipykernel) Cirq PennyLane Qiskit

Console

Python 3 (ipykernel) Cirq PennyLane Qiskit

Other

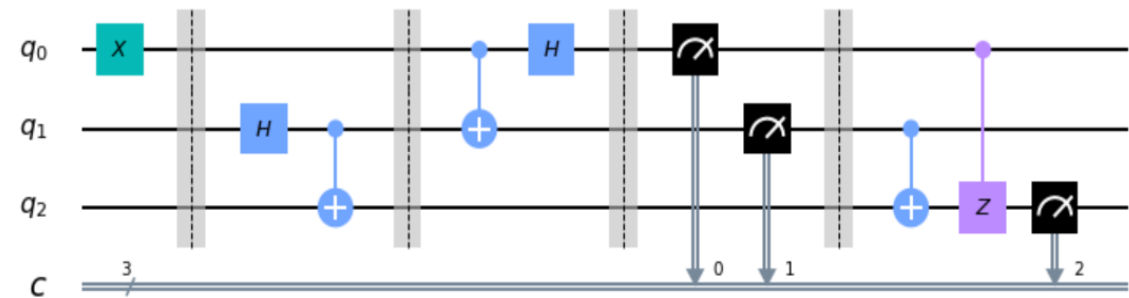
Terminal Text File Markdown File Python File Show Contextual Help

<https://jhub3.jinr.ru>

Equipment:

- 2x Intel Xeon E5 2698v4 (20 Cores @ 2.2 GHz),
- 512 GB RAM,
- 8x NVIDIA Tesla V100 SXM2 16 GB HBM2

```
%matplotlib inline  
circuit.draw(output='mpl')
```

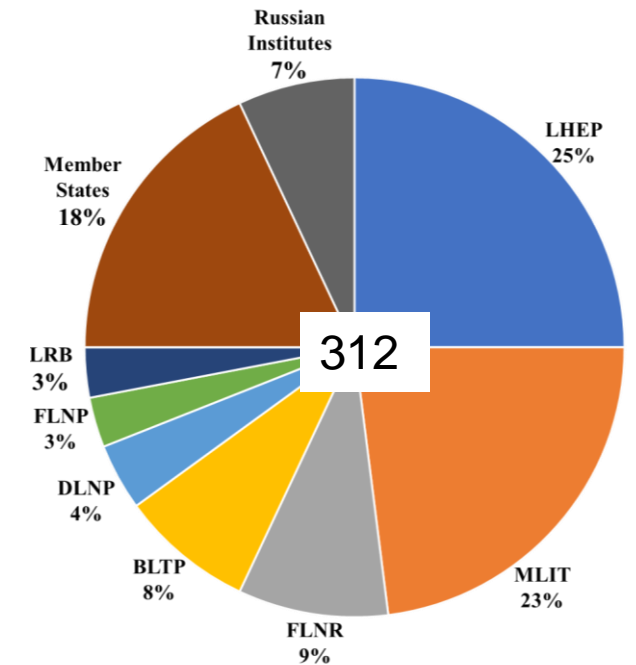
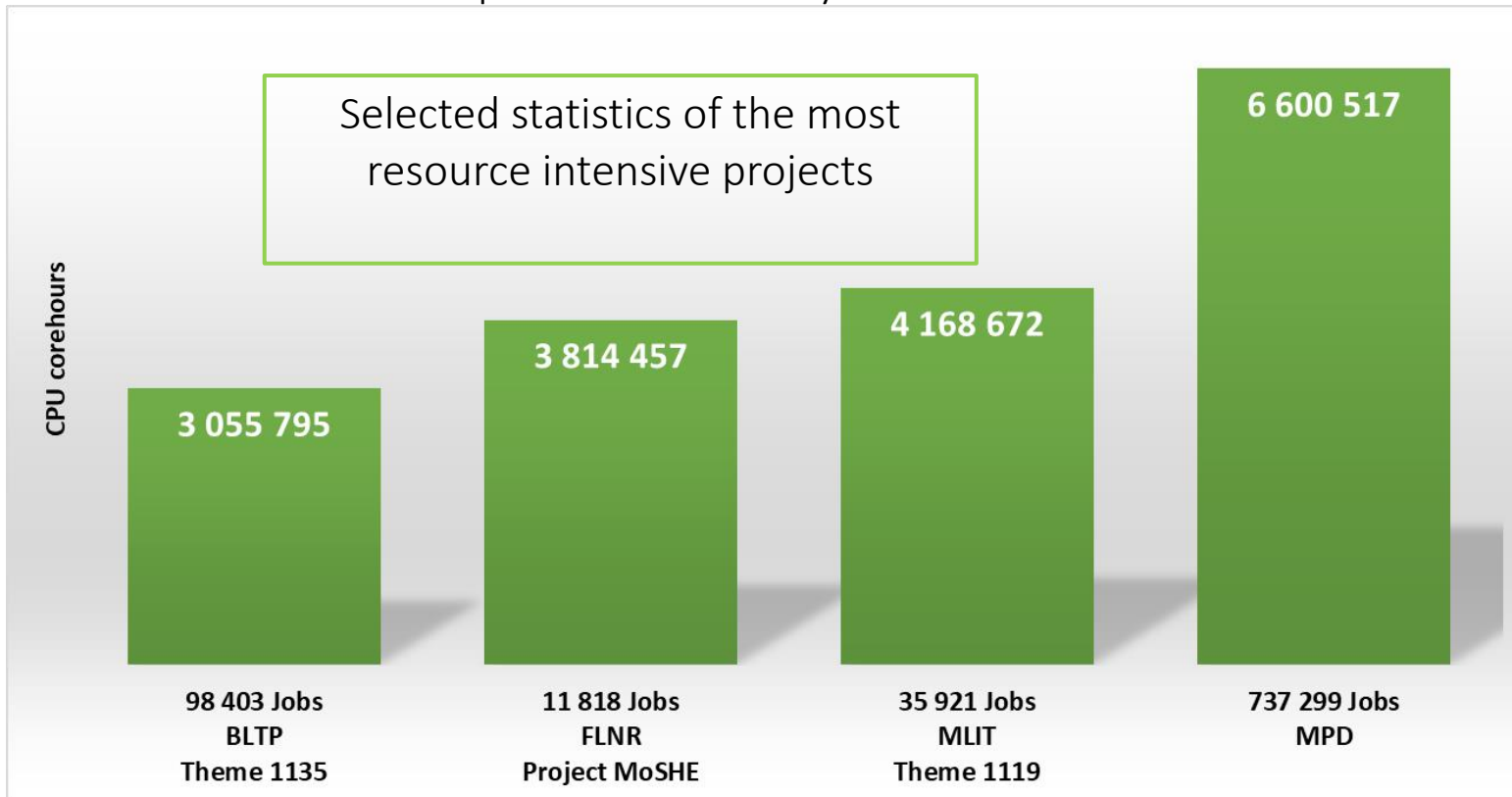


Using of the “Govorun” Supercomputer in 2023

The resources of the “Govorun” SC are used by scientific groups from all the Laboratories of the Institute within **25 themes** of the JINR Topical Plan.

The projects that mostly intensive use the CPU resources of the “Govorun” SC:

- NICA megaproject,
- simulation of complex physical systems,
- computations of the properties of atoms of superheavy elements,
- calculations of lattice quantum chromodynamics.

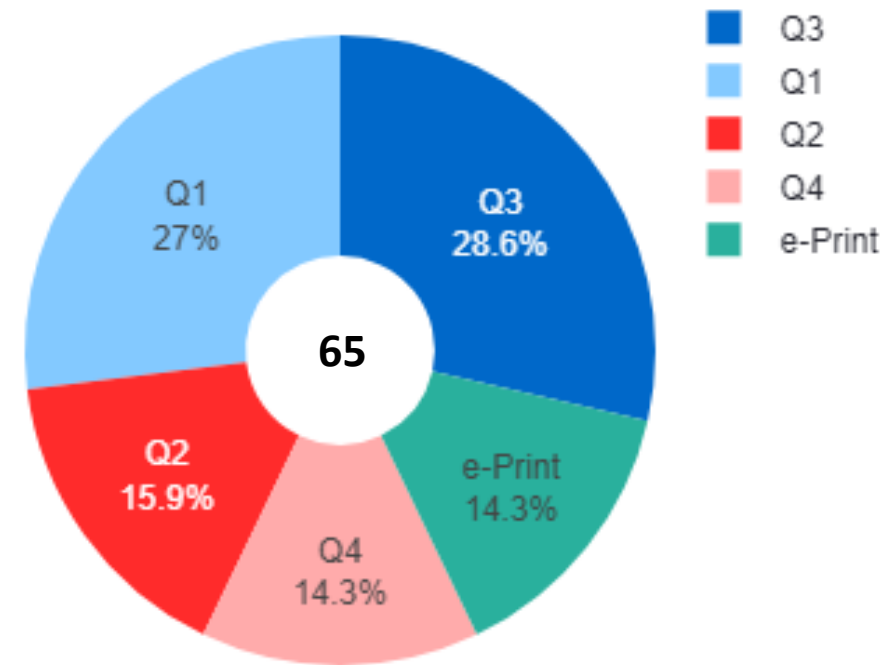


Within 2023, all groups of “Govorun” SC users completed **640,861 jobs on the CPU** component, which corresponds to 16 million core hours, and **7,808 jobs on the GPU** component, which corresponds to 45,400 GPU hours. The average load of the **CPU component** was **96.4%**, while the **GPU component** load was **91.2%**.

Publications

Over the past year, users of the heterogeneous HybriLIT platform published 65 articles in various fields:

- physics of elementary particles and the atomic nucleus,
- high energy physics,- biophysics and chemistry,
- neural network approach, methods and algorithms of machine learning and deep learning (ML/DL), etc.



Research results obtained using the supercomputer resources since 2018 are presented in **325** publications. Two of them were prepared in Nature Physics:

- M. Kircher ... , O. Chuluunbaatar et al. Kinematically complete experimental study of Compton scattering at helium atoms near the threshold. Vol. 16. № 4. Pp. 756-760
- BM@N Collaboration. Unperturbed inverse kinematics nucleon knockout measurements with a 48 GeV/c carbon beam. Vol. 17. Pp. 693-699

Educational activities: training courses



Modern information technologies in biology and medicine

The international workshop “Modern information technologies in biology and medicine”

22-24 November 2023.

«Tutorial on the use of Python for tasks in Bio-Medical research»

60 участников



Осенняя Школа по информационным технологиям ОИЯИ 16-20 Октября 2023

«Инструментарий на основе Python-библиотек и экосистемы Jupyter для решения научных и прикладных задач»

Хакатон по параллельным вычислениям
60 участников

210

**Participants
in 2023 г.**

СОГУ

ЦЕНТР ОТКРЫТОГО
ОБРАЗОВАНИЯ
НА РУССКОМ ЯЗЫКЕ
И ОБУЧЕНИЯ РУССКОМУ ЯЗЫКУ



V Международная летняя школа молодых ученых «Современные информационные технологии для решения научных и прикладных задач» 14-17 Июня 2023.

«Инструментарий на основе Python-библиотек и экосистемы Jupyter для решения научных и прикладных задач»

70 участников



МИЦНТ СНГ

XVI Международная стажировка молодых ученых стран СНГ Май-Июнь 2023

«Как научить компьютер "видеть"»

20 участников

“Govorun” supercomputer



http://hlit.jinr.ru/

The screenshot shows the main page of the HybriLIT platform. At the top, there is a navigation bar with the hYBRI LIT/JINR logo and menu items: ПЛАТФОРМА «HYBRILIT», ПОЛЬЗОВАТЕЛЯМ, ДОСТУП К РЕСУРСАМ, ПРОЕКТЫ, О НАС, and НОВОСТИ. The main content area features a large blue banner with a stylized portrait of a man and the text: **Гетерогенная платформа «HybriLIT»** and **Суперкомпьютер «Говорун» / учебно-тестовый полигон «HybriLIT»**. Below the banner is a horizontal menu with four items: РЕГИСТРАЦИЯ, СЕРВИСЫ, ИНСТРУКЦИЯ ПО РАБОТЕ, and ОБУЧАЮЩИЕ ВИДЕО.

Гетерогенная платформа «HybriLIT»

Гетерогенная платформа «HybriLIT» является частью Многофункционального информационно-вычислительного комплекса (МИВК), Лаборатории информационных технологий ОИЯИ, г. Дубна. Гетерогенная платформа состоит из Суперкомпьютера «Говорун» и учебно-тестового полигона «HybriLIT».

Суперкомпьютер «Говорун» представляет собой двухкомпонентную систему:

- CPU-компонента, базирующуюся на новейших архитектурах Intel (процессоров Itanium 2 и Xeon Phi).
- GPU-компонента, базирующуюся на узлах NVIDIA DGX-1 Volta.

Учебно-тестовый полигон имеет гетерогенную структуру вычислительных узлов: многоядерные процессоры, сопроцессоры Intel Xeon Phi и линейки графических процессоров NVIDIA. Студентам осваивать работу на новейших вычислительных архитектурах.

The screenshot shows the registration page of the HybriLIT platform. The navigation bar is the same as the main page. The main content area is titled **Регистрация**. Below the title, there is a red warning message: **Для получения доступа к ресурсам платформы «HybriLIT» необходимо ознакомиться с правилами использования ресурсов платформы.** The page is divided into two main sections: **Сотрудникам ОИЯИ** and **Пользователям из других организаций**. Each section contains a list of instructions for registration. The **Сотрудникам ОИЯИ** section includes: filling out a registration form, which will be sent by email; printing and signing the form; and sending it to the IT department. The **Пользователям из других организаций** section includes: sending an official letter to the director; printing and signing the form; and sending it to the IT department.

Пользователям суперкомпьютера «Говорун»

также представители научных организаций стран-участниц

и определяющей приоритетность доступа к

The screenshot shows the Quick Start page of the HybriLIT platform. The navigation bar is the same as the main page. The main content area is titled **«Quick Start»** and **Запуск задач**. Below the title, there is a section **Полезные ссылки:** with a list of links: **Об учебно-тестовом полигоне**, **JupyterHub**, **Putty**, **Установленное ПО**, and **Инструкция по работе**.

«Quick Start»

Запуск задач

Полезные ссылки:

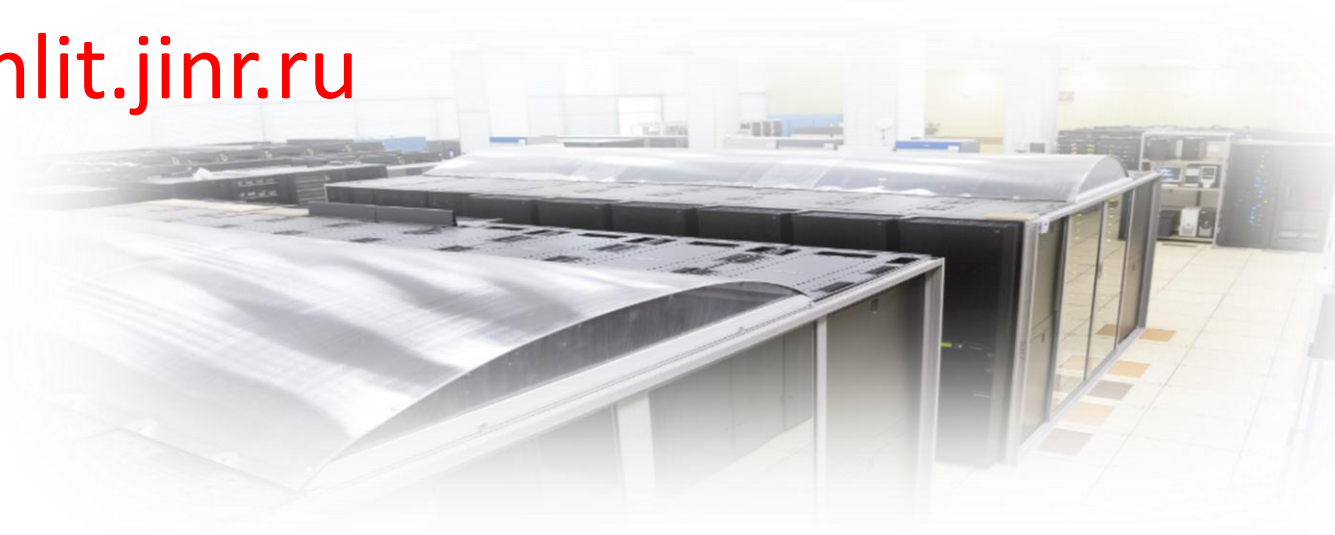
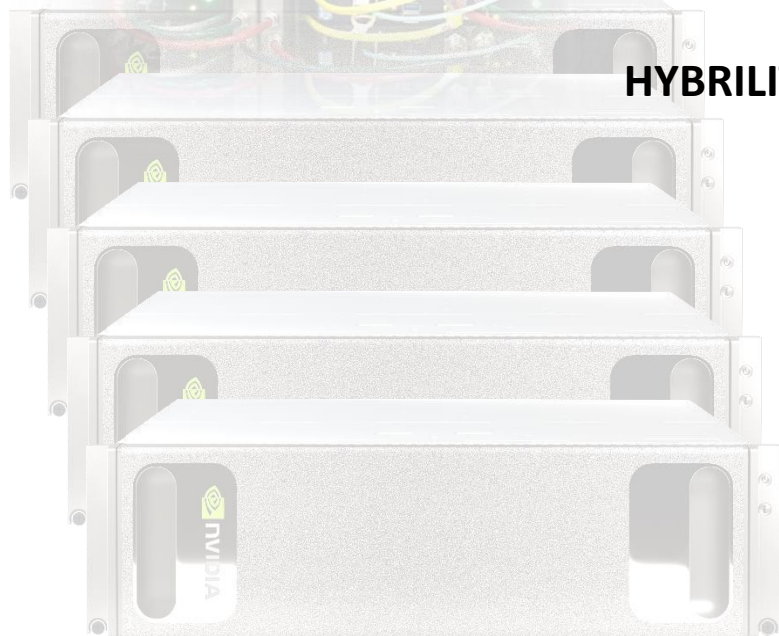
- Об учебно-тестовом полигоне
- JupyterHub
- Putty
- Установленное ПО
- Инструкция по работе



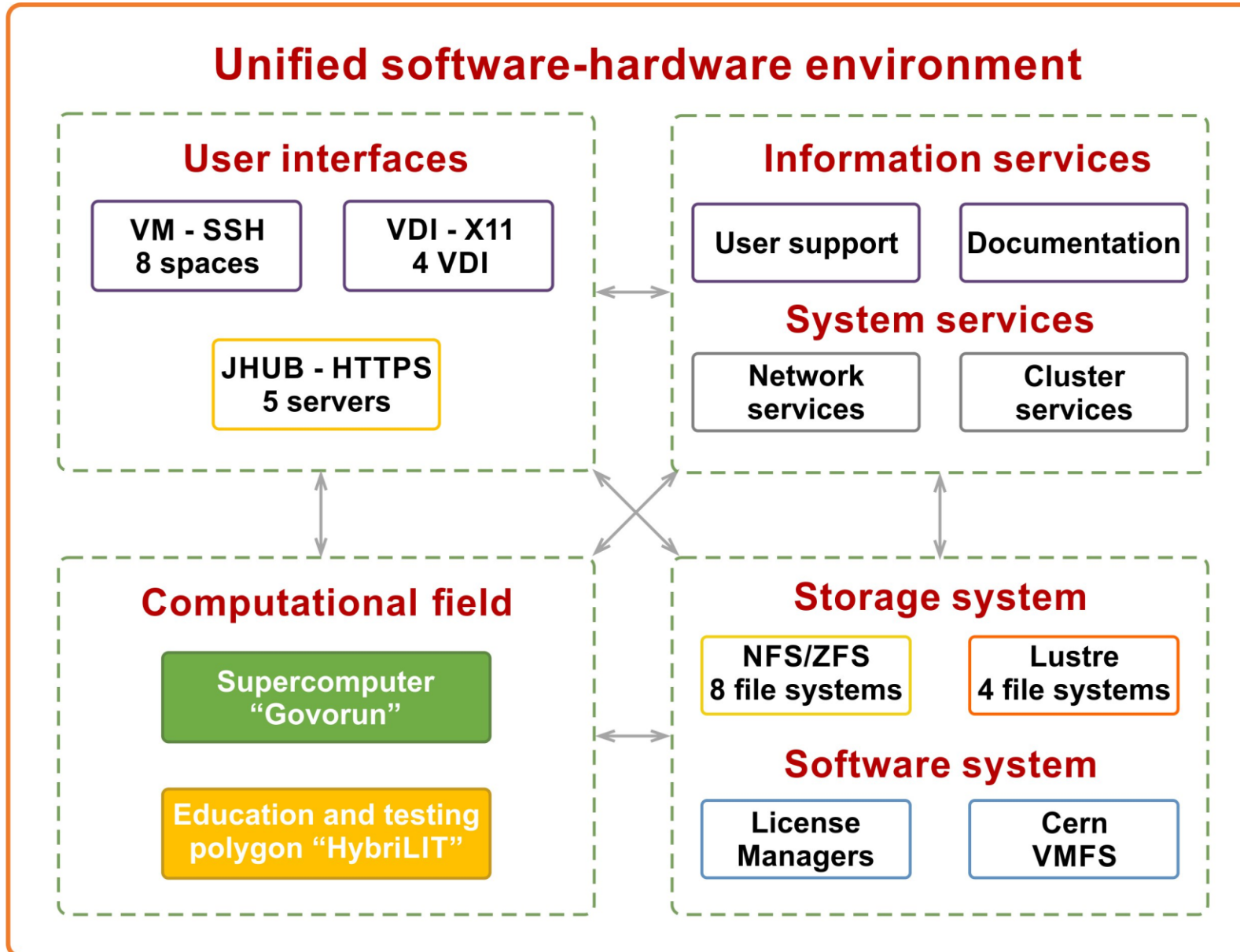
Thank you for your attention

HYBRILIT HETEROGENEOUS PLATFORM at MLIT JINR:

<http://hlit.jinr.ru>



MICC component: HybriLIT platform



The unified software and information environment of the HybriLIT platform allows using the education and testing polygon, exploring the possibilities of novel computing architectures and IT-solutions, developing and debugging applications, and carrying out computations on the supercomputer.

MICC component: HybriLIT platform

