ОБЪЕДИНЕННЫЙ
ИНСТИТУТ
ЯДЕРНЫХ
ИССЛЕДОВАНИЙ

JINR MLIT

Methods and technologies of data processing in heterogeneous computing environments

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Meshcheryakov Laboratory of Information Technologies

THE XVI-th INTERNATIONAL SCHOOL-CONFERENCE
"THE ACTUAL PROBLEMS OF MICROWORLD PHYSICS"
Minsk, Belarus, 24 – 31 August, 2025

Эволюция ИТ

- менялись концепции
- круг и сложность решаемых задач
- возникал новый технологический набор
- углублялась специализация разработчиков
- сокращалось время ввода новых продуктов и сервисов

первые цифровые платформы поддержки, работающих в реальном времени

Первое поколение (1960-е годы) — мейнфреймы

Второе поколение (1970-е годы) — универсальные ЭВМ

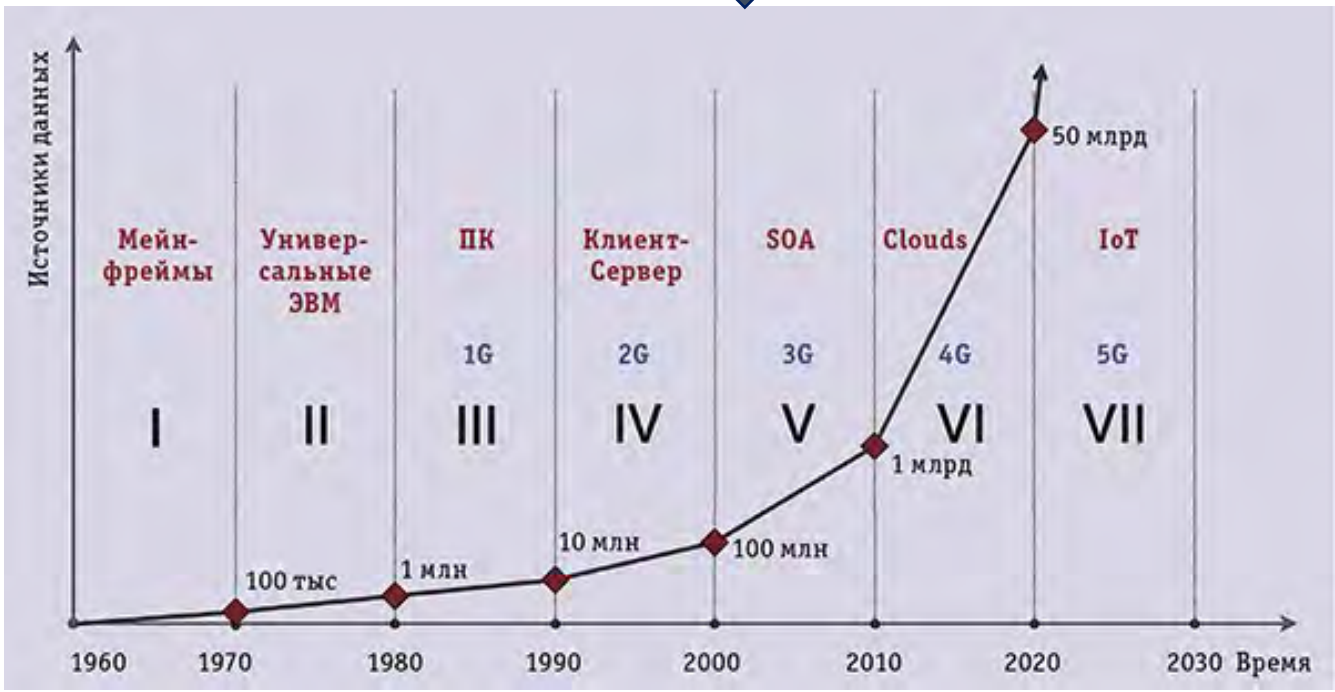
Третье поколение (1980-е годы) — персональные компьютеры

Четвертое поколение (1990-е годы) — клиент-сервер

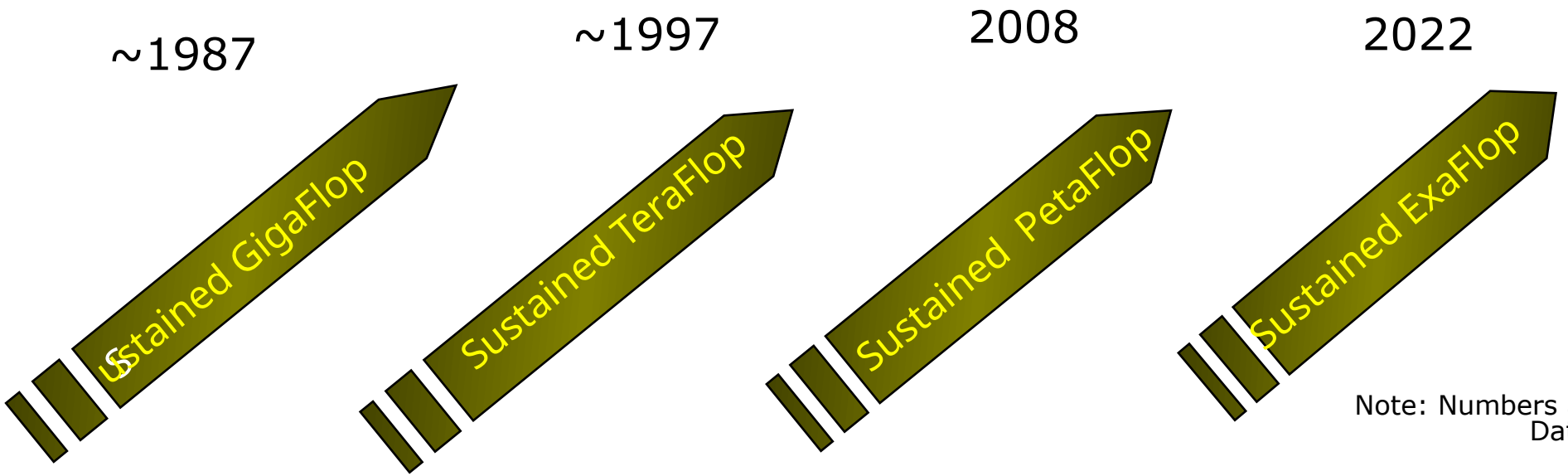
Пятое поколение (2000-е годы) — сервисная архитектура

Шестое поколение (2010-е годы) — облака

Седьмое поколение (2020-е годы) — IoT, искусственный интеллект, квантовые вычисления



Этапы развития суперкомпьютеров согласно закону Мура (от Gigaflops до Exaflops)



Note: Numbers are based on Linpack Benchmark.
Dates are approximate.

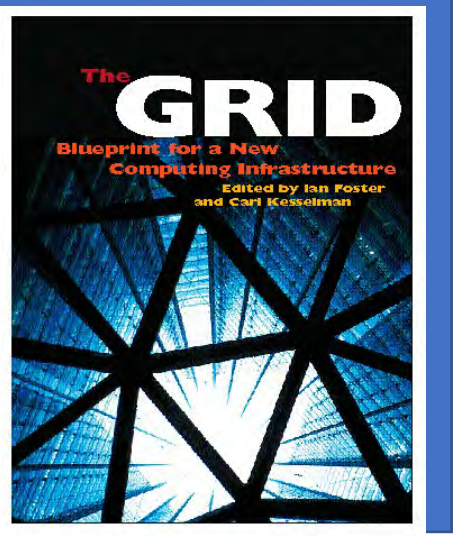
The El Capitan system at the Lawrence Livermore National Laboratory, No. 1 system on the TOP500.
El Capitan has 11,039,616 cores, 1.742 Exaflop/s, 29,580 MW

Frontier - HPE Cray EX235a, AMD
Oak Ridge National Laboratory
9,066,176 cores 1,353.00 exaflops/s
24,507 MW

Grids, clouds, fog, edge, supercomputers…

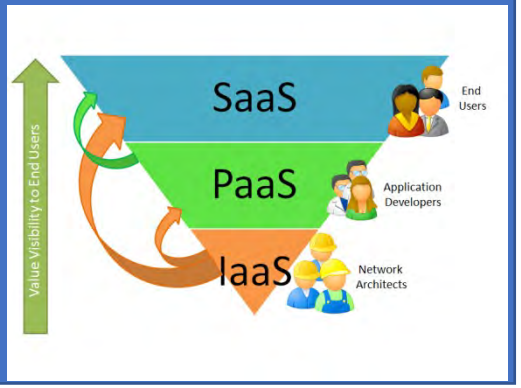
Grids

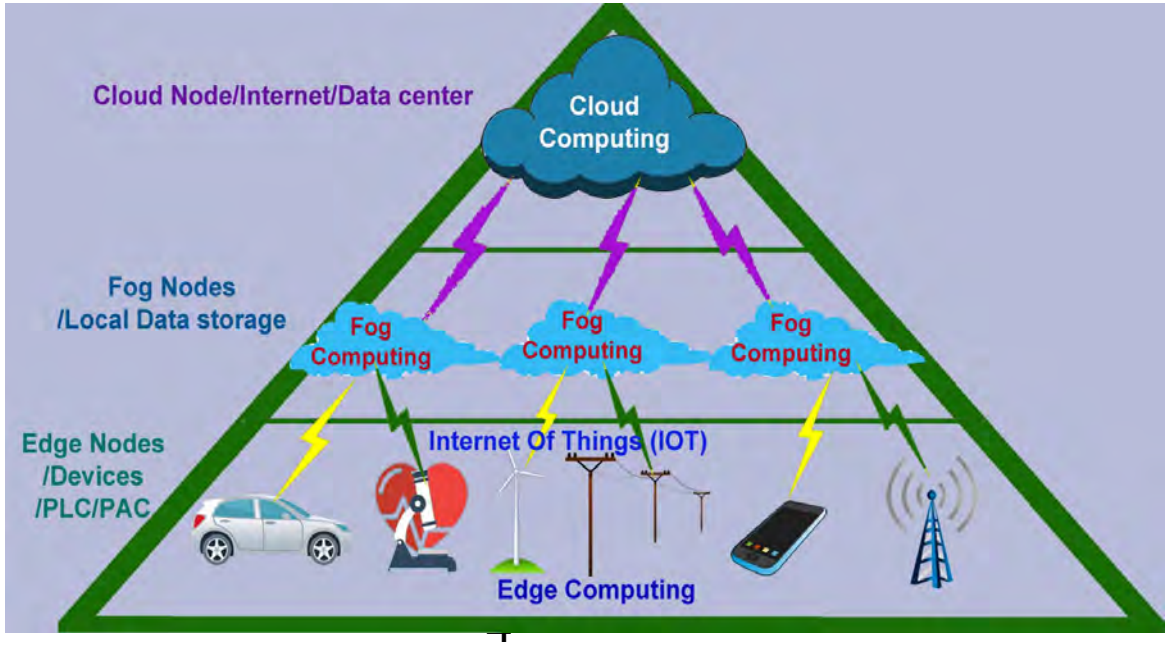
- Collaborative environment
- Distributed resources



Supercomputers

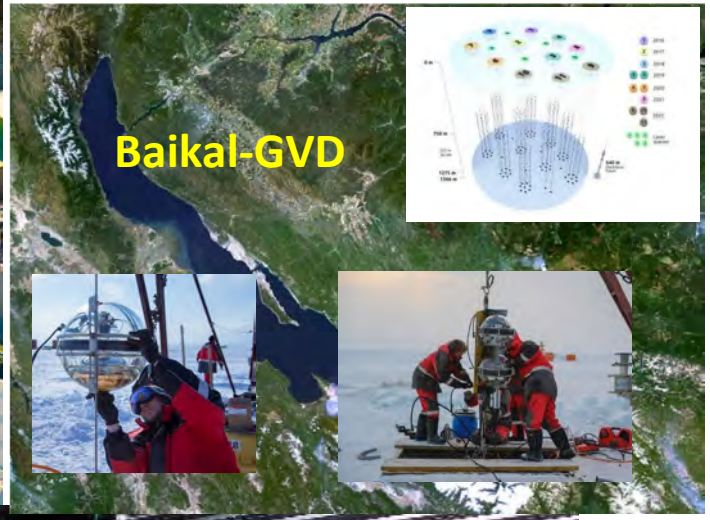
Clouds





JINR


NICA complex
NICA

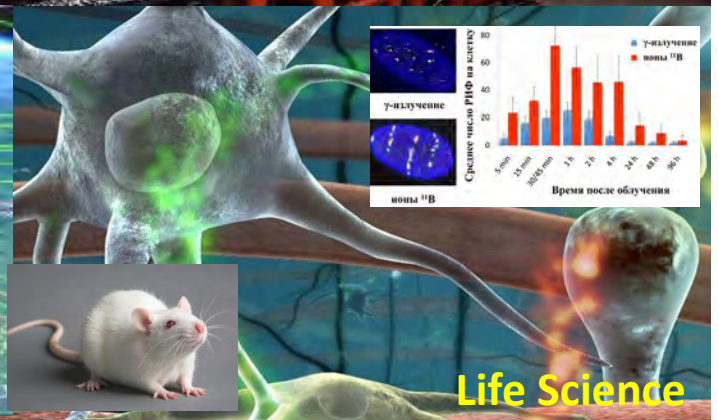

Baikal-GVD


IBR-2M


SHEF


Nuclotron

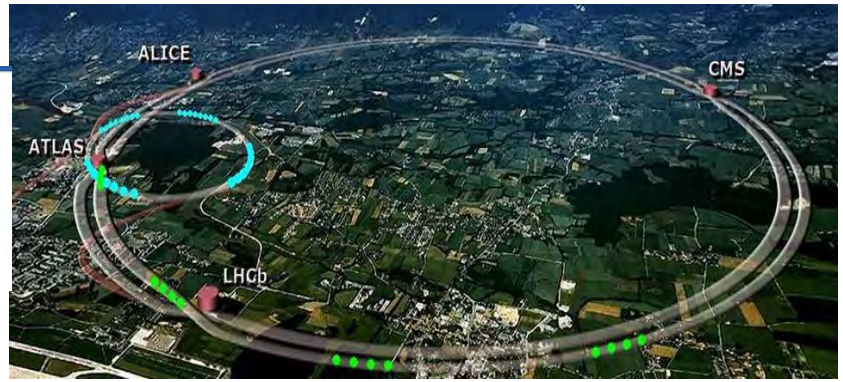

IT & CC


γ-излучение
ионы ¹⁰B
Среднее число РИФ на клетку
Время после облучения
Life Science

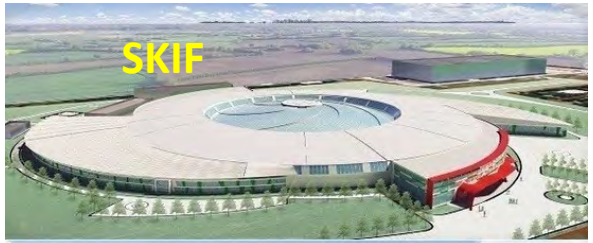

DC-280
SHE-factory
U-400
Heavy and super-heavy nuclei
ACCULINNA-2
Fragment separator
U-400M
Light exotic nuclei
NanoLab
DRIBS-III

HPC+Big Data+AI

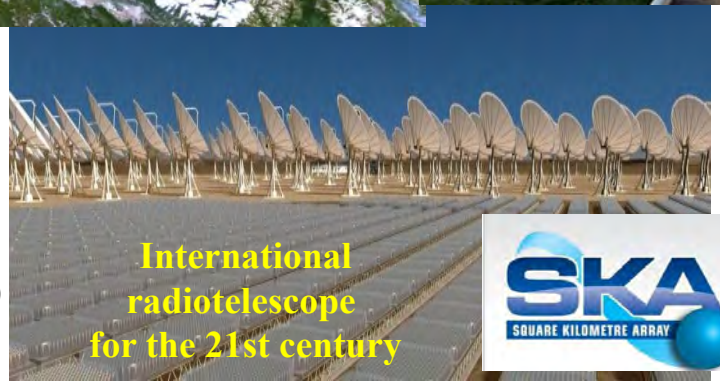
CERN

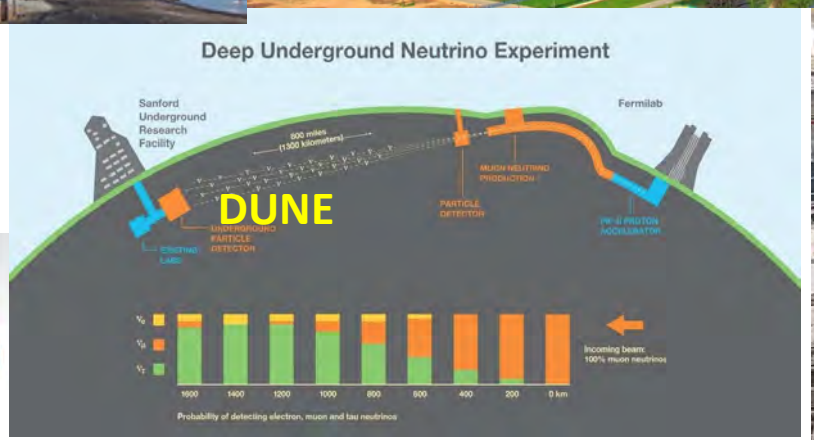


CERN Large Hadron Collider > 400 PB/Year



Square Kilometer Array radio telescope > 1 Eb/Year raw data (estimation)

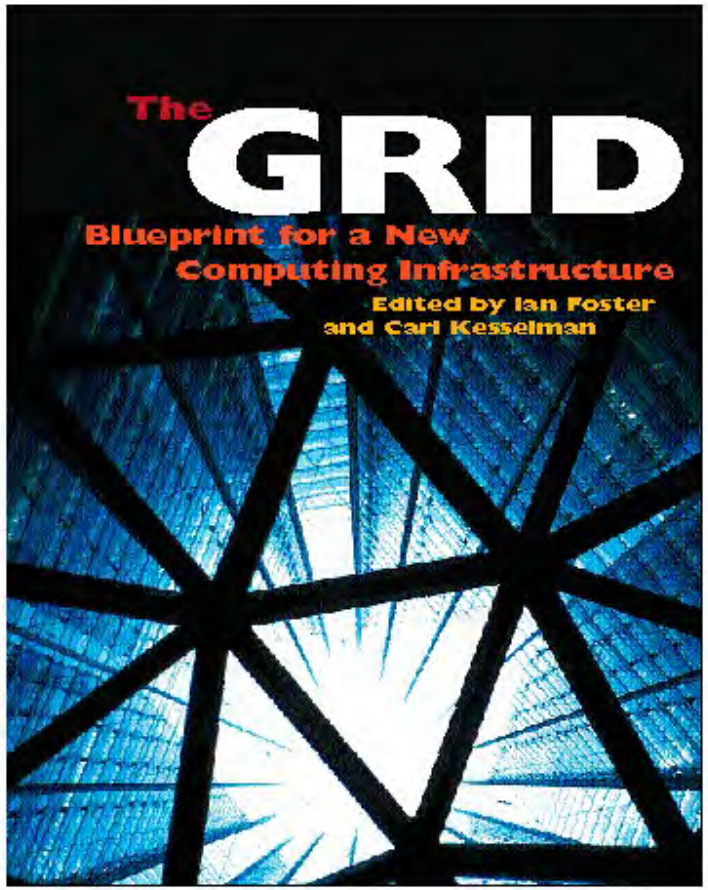




What is GRID

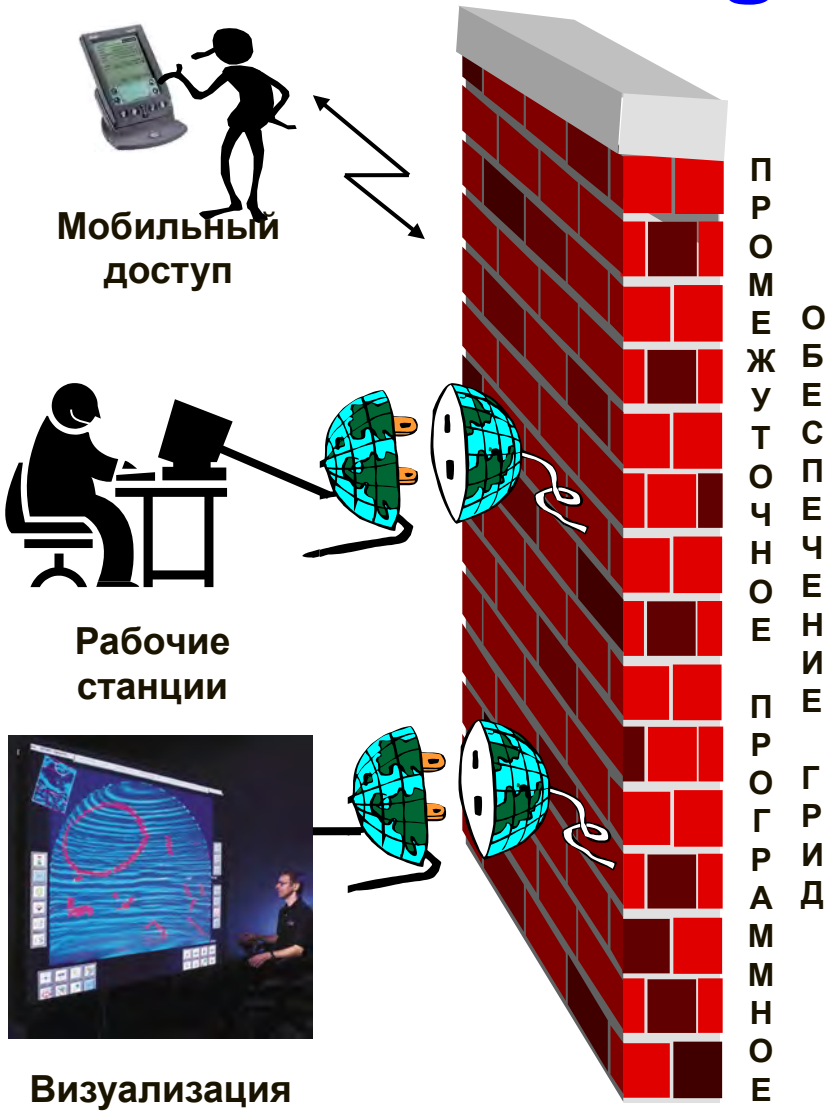
Five Emerging Models of Networked Computing From The Grid:

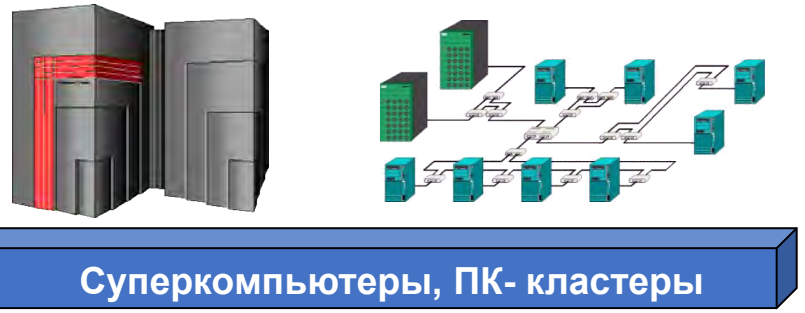
- **Distributed Computing**
- **High-Throughput Computing**
- **On-Demand Computing**
- **Data-Intensive Computing**
- **Collaborative Computing**

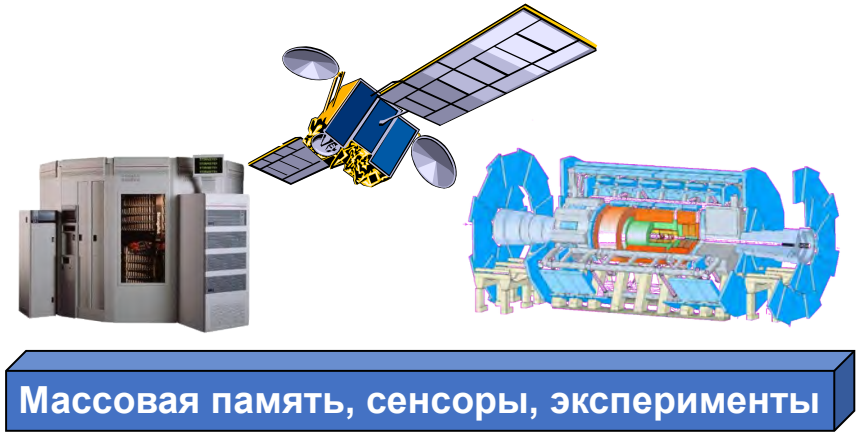


Ian Foster and Carl Kesselman, editors, "The Grid: Blueprint for a New Computing Infrastructure," Morgan Kaufmann, 1999, http://www.mkp.com/grids

GRID- is a means for sharing computing power and data storage via the Internet

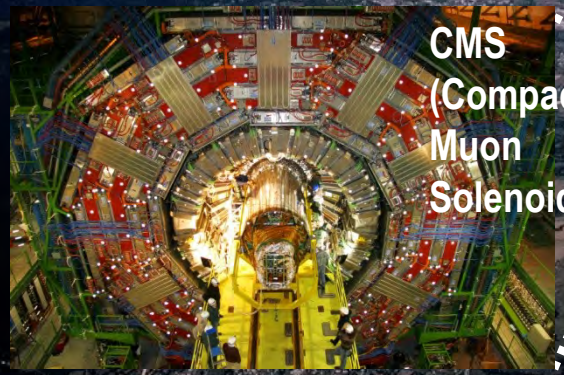






Large Hadron Collider

The Large Hadron Collider (LHC), one of the largest and truly global scientific projects ever, is the most exciting turning point in particle physics.



CMS (Compact Muon Solenoid)

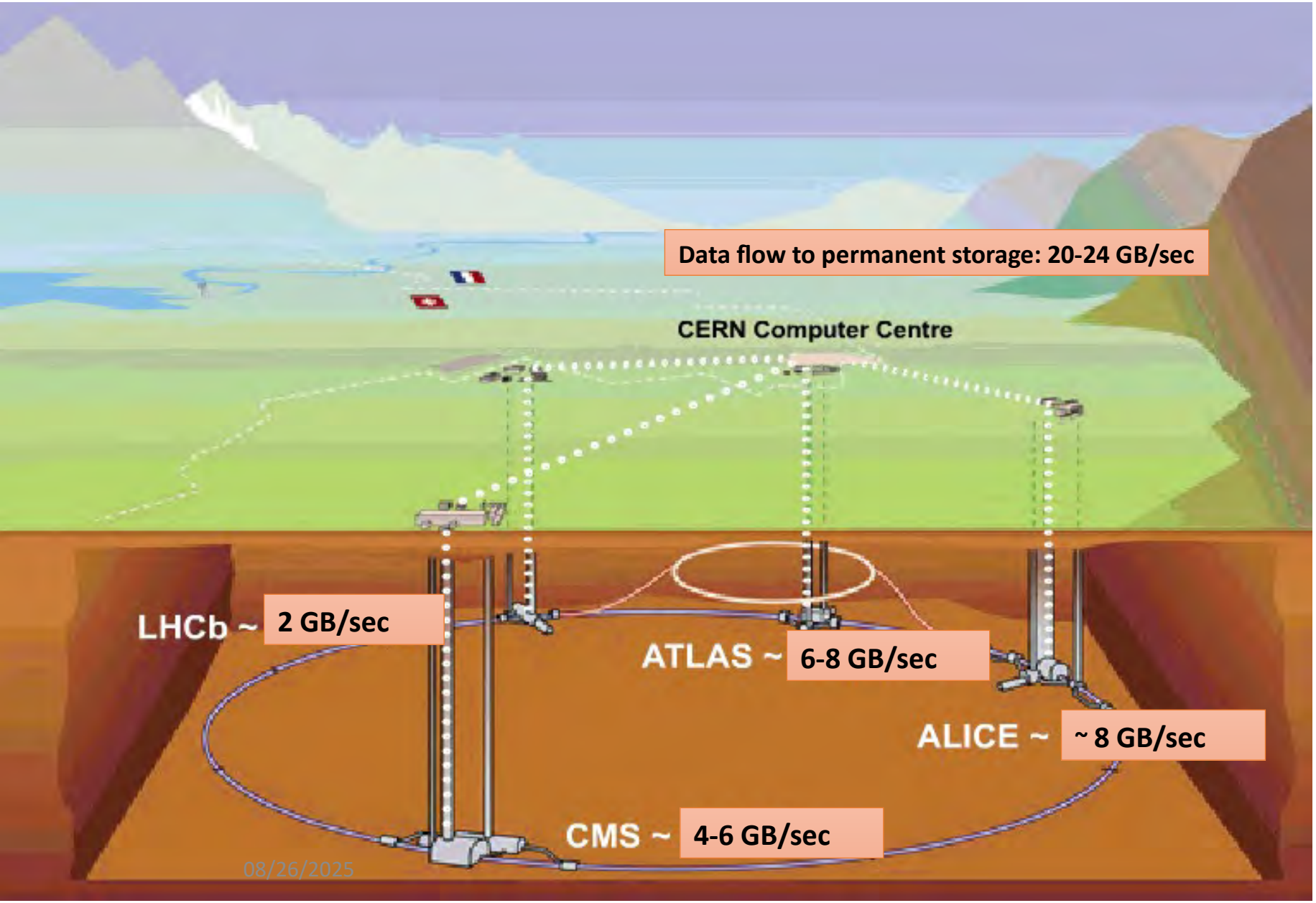
LHCb (Large Hadron Collider beauty experiment)

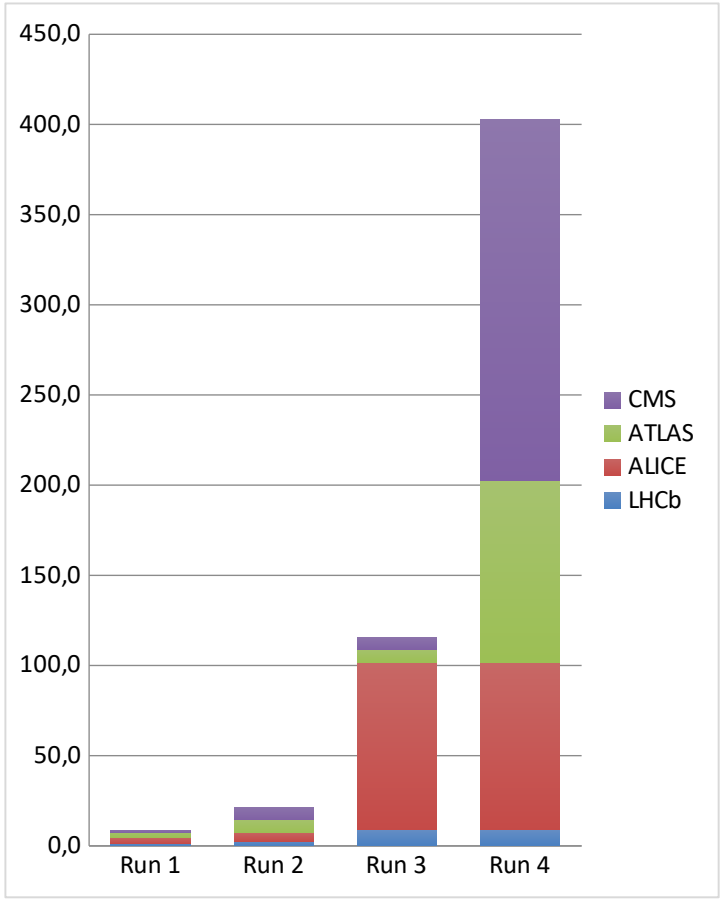
Data flow to permanent storage: 4-6 GB/sec

ALICE (A Large Ion Collider Experiment)

ATLAS (A Toroidal LHC ApparatuS)

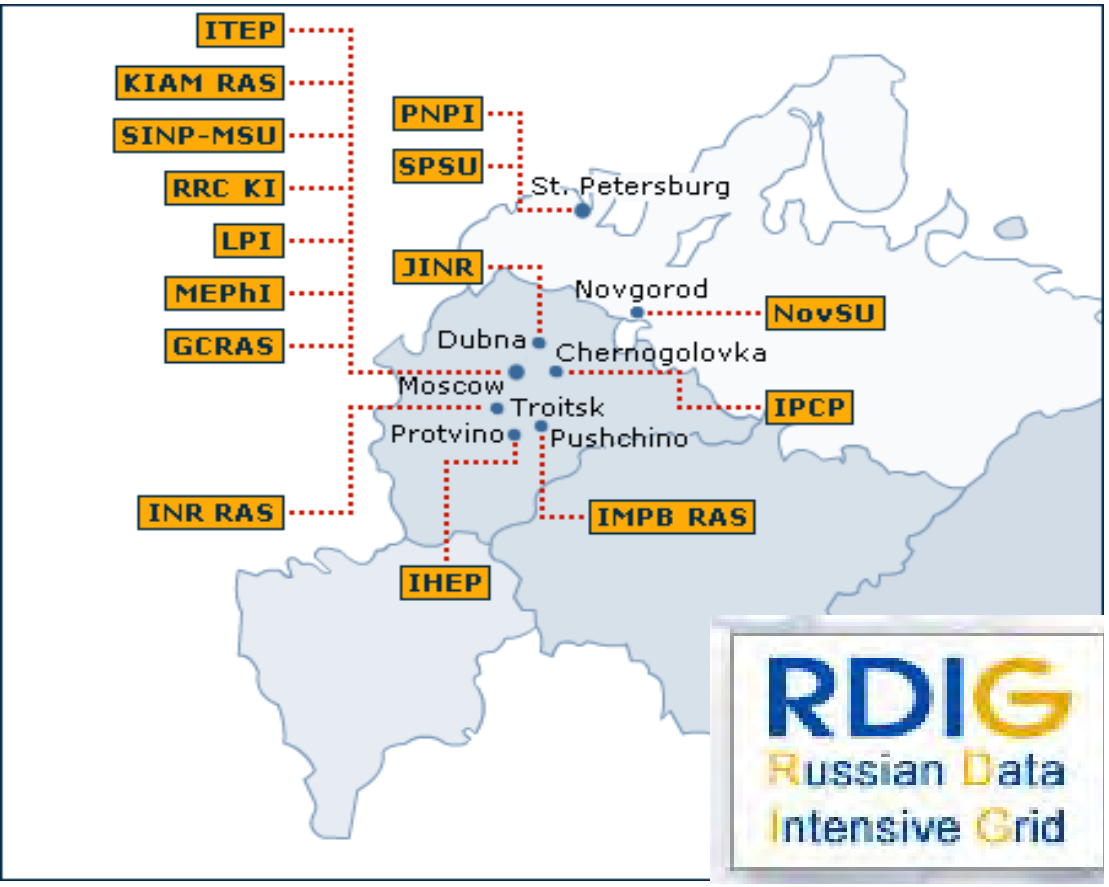
Data Collection and Archiving at CERN





JINR in the Russian Data Intensive Grid infrastructure (RDIG)

The Russian consortium RDIG (Russian Data Intensive Grid), was set up in September 2003 as a national federation in the EGEE project.

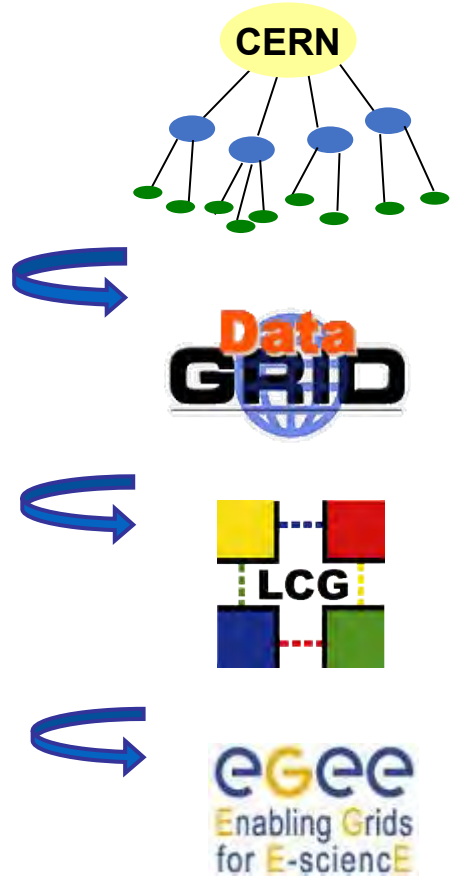


RDIG Resource Centres:

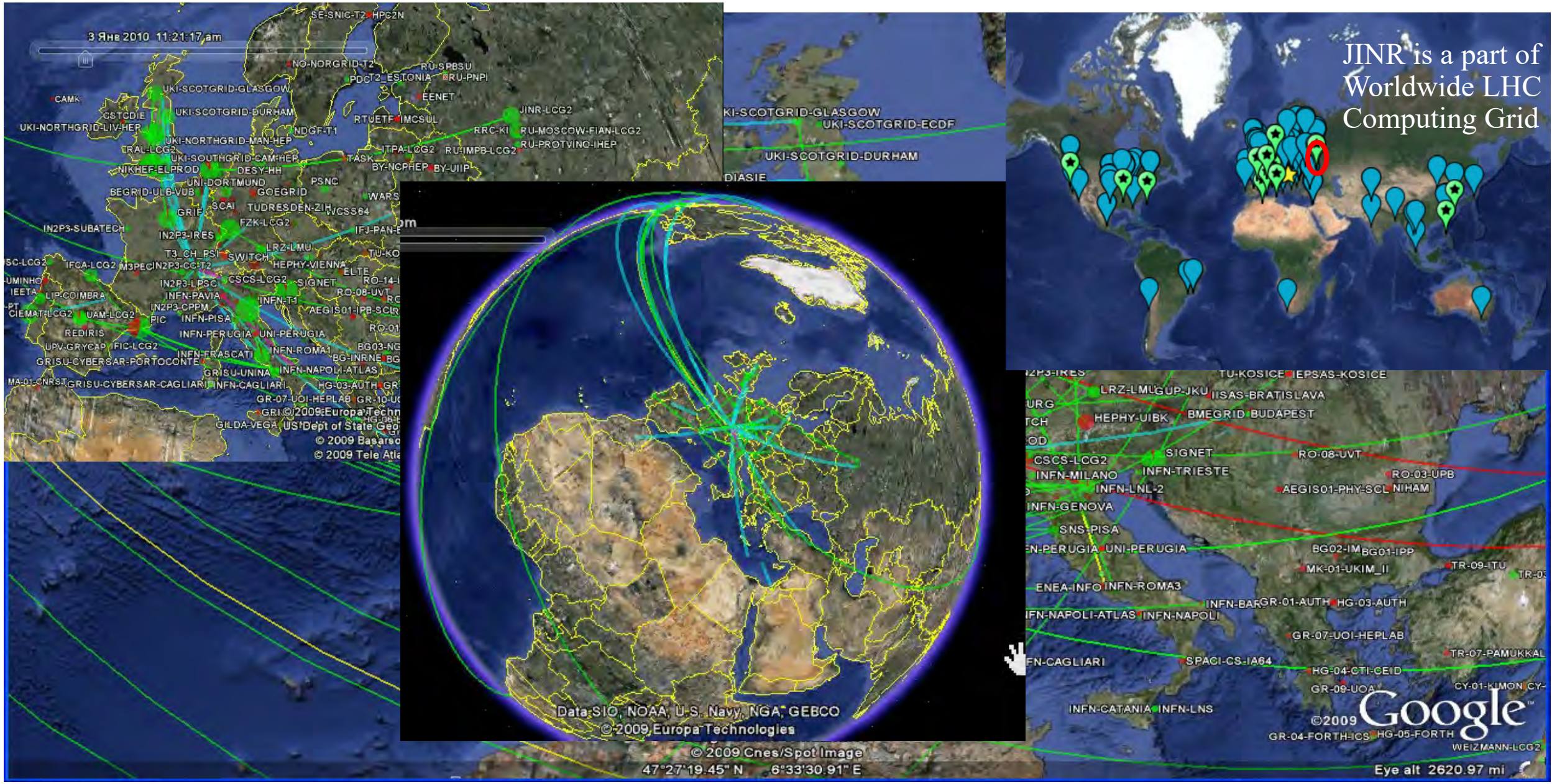
- **ITEP**
- **JINR-LCG2**
- **RRC-KI**
- **RU-Moscow-KIAM**
- **RU-Phys-SPbSU**
- **RU-Protvino-IHEP**
- **RU-SPbSU**
- **Ru-Troitsk-INR**
- **ru-IMPB-LCG2**
- **ru-Moscow-FIAN**
- **ru-Moscow-GCRAS**
- **ru-Moscow-MEPHI**
- **ru-PNPI-LCG2**
- **ru-Moscow-SINP**
- **BY-NCPHEP**
- **Kharkov-KIPT**

Some history

- 1999 – Monarc Project
  - Early discussions on how to organise distributed computing for LHC
- 2001-2003 - EU DataGrid project
  - middleware & testbed for an operational grid
- 2003 – RDIG in Russia (Tier2)
- 2002-2005 – LHC Computing Grid – LCG
- 2004-2006 – EU EGEE project phase 1
- 2005-2006 - PanDA and DIRAC
- 2006-2008 – EU EGEE-II
- 2008-2010 – EU EGEE-III
- 2010-2012 - EGI-InSPIRE
- 2010 – GRID-Cloud
- 2012 – discovery of the Higgs Boson
- 2013 – Tier1 in Russia (JINR and KI)
- 2013 – GRID-Supercomputer TITAN



The Worldwide LHC Computing Grid (WLCG)



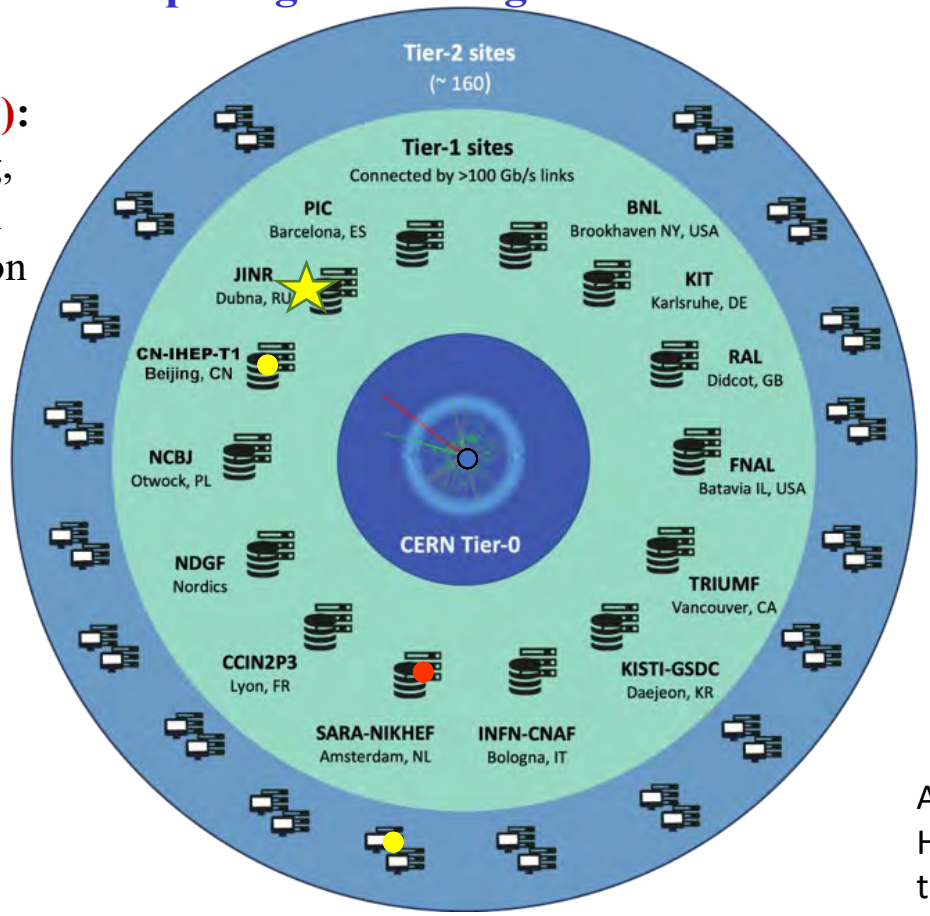
Worldwide LHC Computing Grid (WLCG)

The mission of the **WLCG** is to provide global computing resources for the storage, distribution and analysis ~50-70 Petabytes of data expected every year of operations from the LHC. **Integrates computer centres worldwide that provide computing and storage resource into a single infrastructure accessible by all LHC physicists**

Tier0 (CERN): data recording, reconstruction and distribution

Tier1: permanent storage, re-processing, analysis

Tier2: Simulation, end-user analysis



The mission of the WLCG project is to provide global computing resources to store, distribute and analyze the ~400 PB of data expected every year of operations from the Large Hadron Collider.

WLCG computing enabled physicists to announce the discovery of the Higgs Boson on 4 July 2012.

42 countries

170 sites

~2 M CPU cores

2 EB of storage

> 2 M jobs/day

100-250 Gb/s links

At the Nobel Prize ceremony for the discovery of the Higgs boson, CERN Director Rolf Heuer directly named grid technologies as one of the three pillars of success (along with the LHC accelerator and physics facilities). Without the organization of the grid infrastructure at the LHC, it would be impossible to process and store the colossal volume of data coming from the collider, and therefore, to make scientific discoveries. Today, not a single large project can be implemented without the use of a distributed infrastructure for data processing.

Meshcheryakov Laboratory of Information Technologies

M.G. Mesheryakov
(17.09.1910 - 24.05.1994)

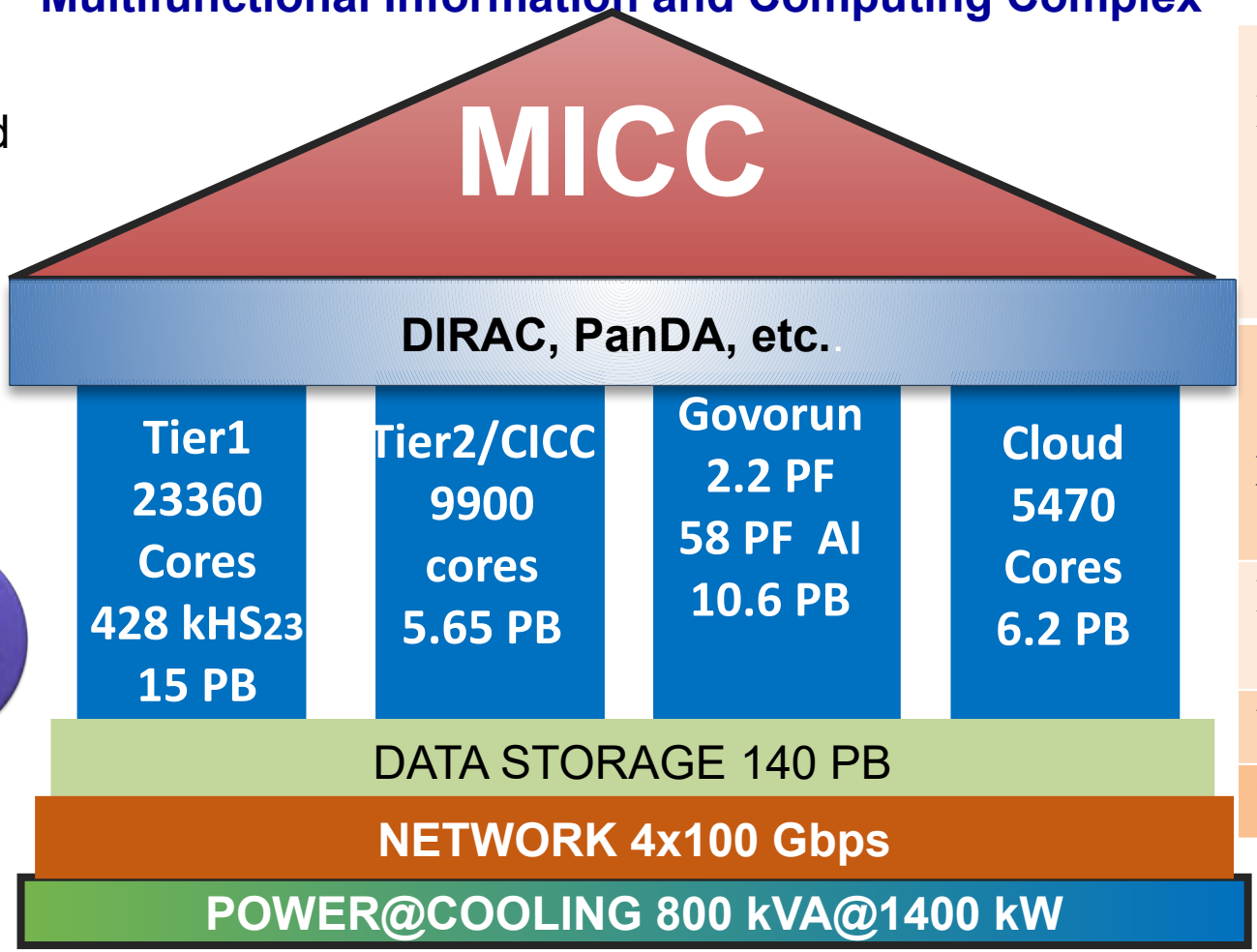
N.N. Govorun
(18.03.1930 - 21.07.1989)

Meshcheryakov Laboratory of Information Technologies of the Joint Institute for Nuclear Research in Dubna was founded in August 1966. The main directions of the activities at the Laboratory are connected with the provision of networks, computer and information resources, as well as mathematical support of a wide range of research at JINR.

Meshcheryakov Laboratory of Information Technologies

Scientific IT ecosystem:
coordinated development of interconnected IT technologies and computational methods

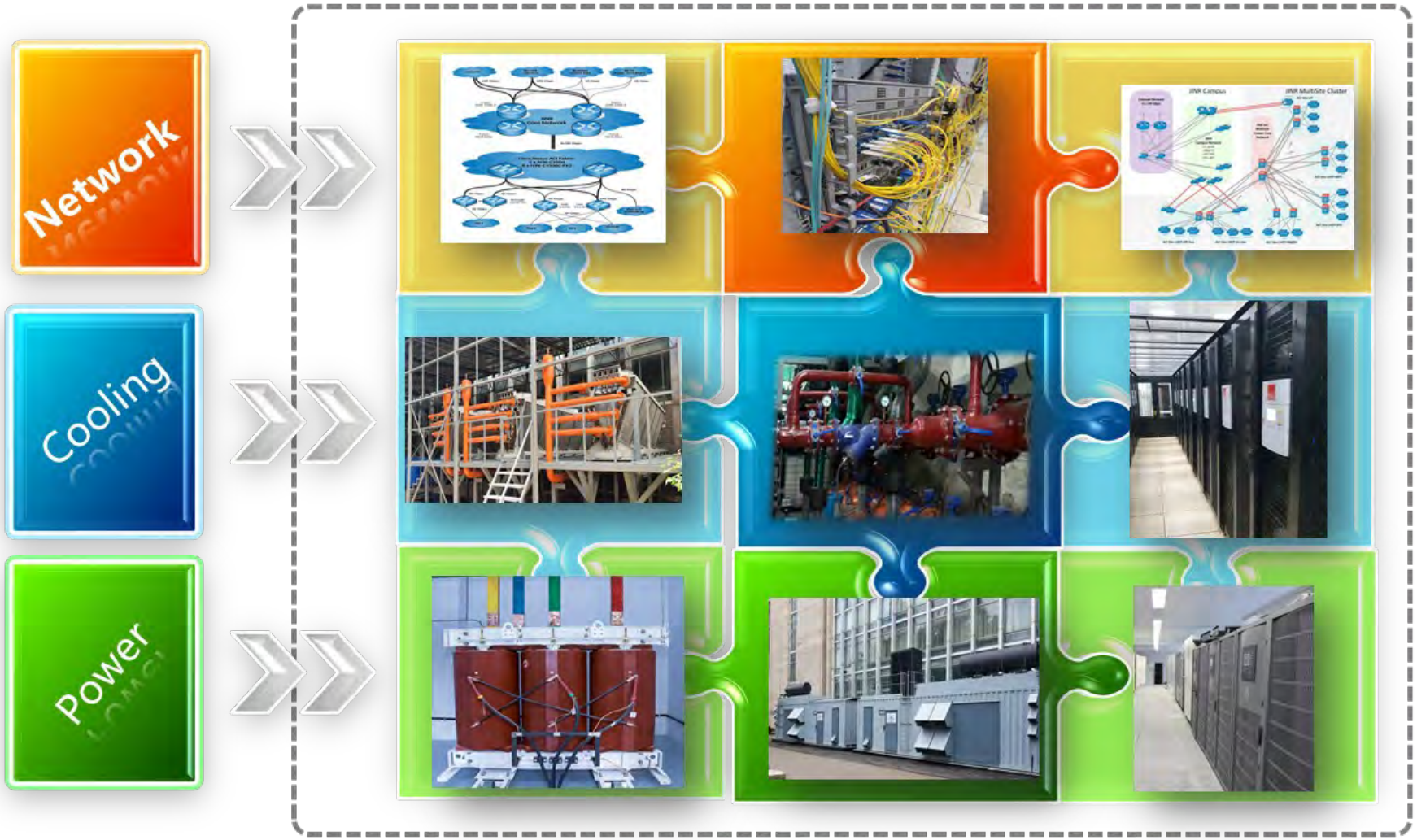
Multifunctional Information and Computing Complex



Scientists Doctors of Science Candidates of Science	**115** 21 62
Specialists (engineers, programmers)	**136**
Management	**18**
Workers	47
Total	316

- **Provide IT services** necessary for the fulfillment of the JINR Topical Plan on Research and International Cooperation in an efficient and effective manner
- **Building world-class competence in IT and computational physics**
- **24/7 support of computing infrastructure and services**

MICC Power @ Cooling @ Network

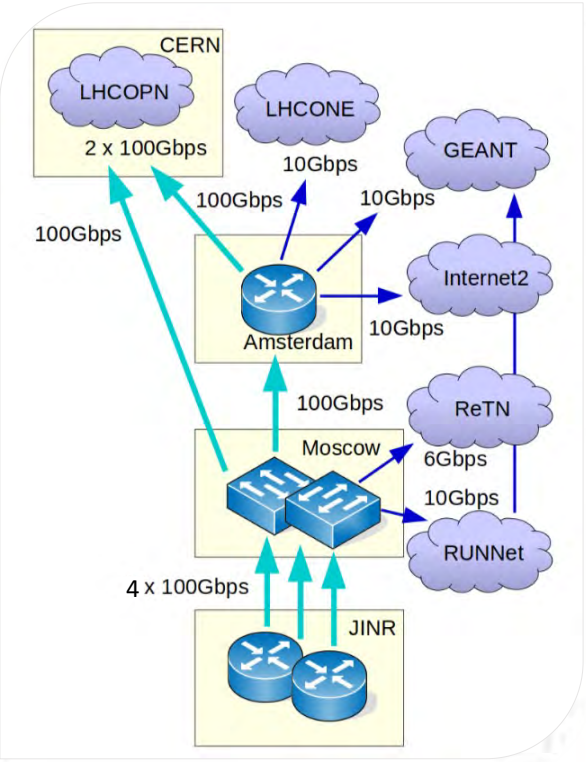


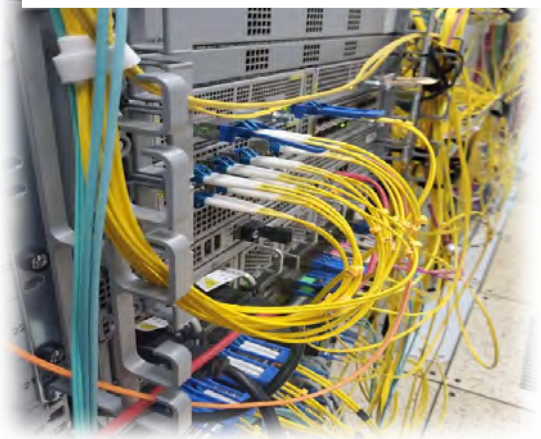
Wide Area Network 4x100 Gbps
Cluster Backbone 4x100 Gbps
Campus Backbone 2x100 Gbps

Dry chillers
In-Row systems
Total cooling 1400 kW

Uninterruptible power supplies (UPS) 8x300 kVA
Diesel-generator units (DGU) 2x1500 kVA

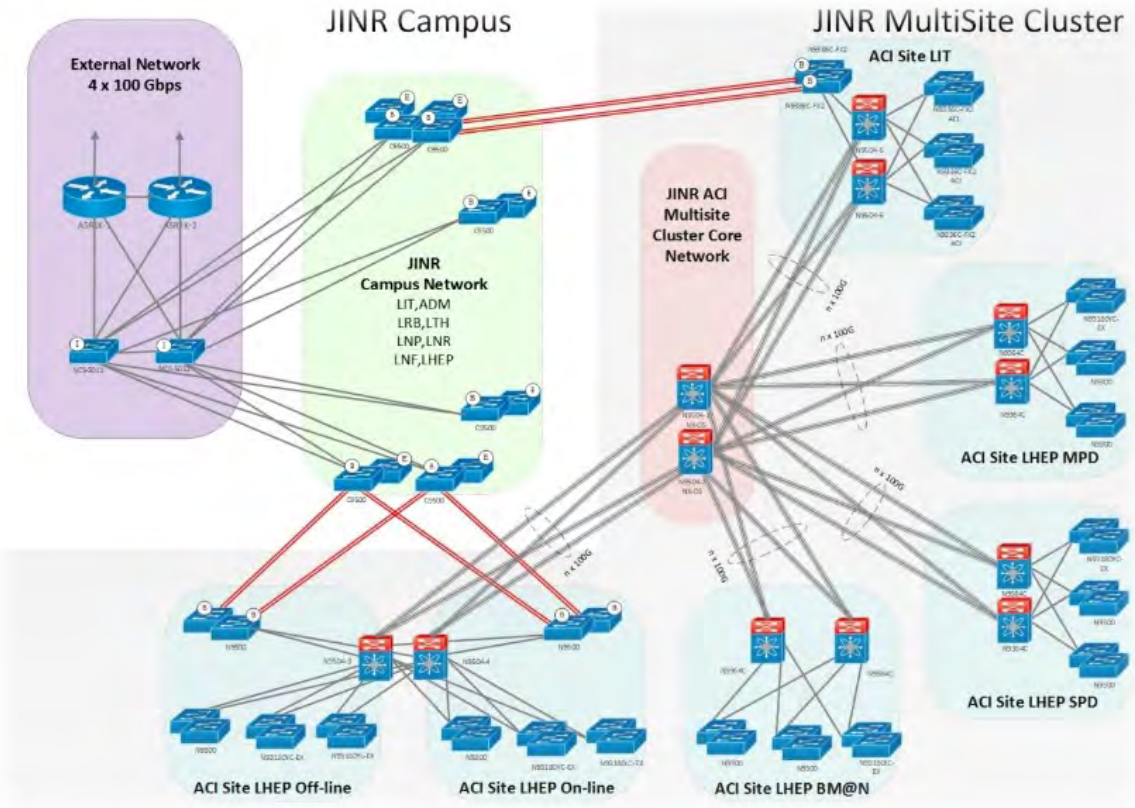
Network Infrastructure





MLIT ensures the reliable and fault-tolerant operation of all components of the network infrastructure:

- JINR-Moscow 4x100 Gbit/s
- JINR-CERN 100 Gbit/s and JINR-Amsterdam 100 Gbit/s
- multi-site cluster network with a bandwidth of 4x100 Gbit/s for the NICA megaproject
- local area network with a bandwidth of 2x100 Gb/s



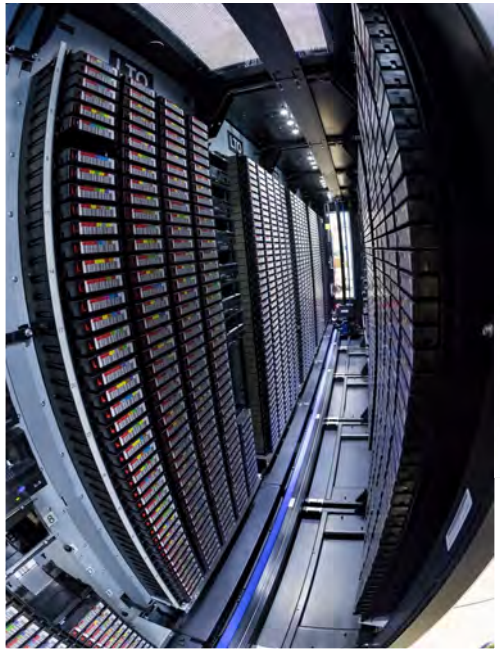
The JINR LAN comprises:

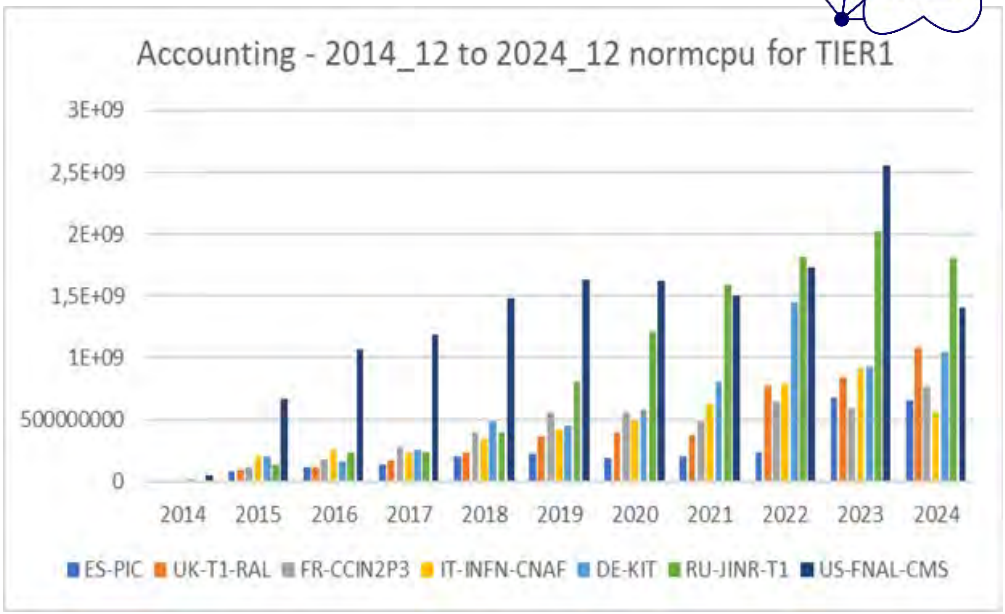
14017 network elements
23276 IP-addresses ipv4
1491 IP-addresses ipv6
5934 users registered within the network
4937 *.jinr.ru service users
1153 digital library users
967 remote VPN
157 EDUROAM users

Network traffic in 2024

42.53 PB - input
20.62 PB - output

Tier1 for CMS at JINR





- 23360 cores
- 428 kHS23
- 15.5 PB disks
- 100 PB tape
- 100% reliability and availability

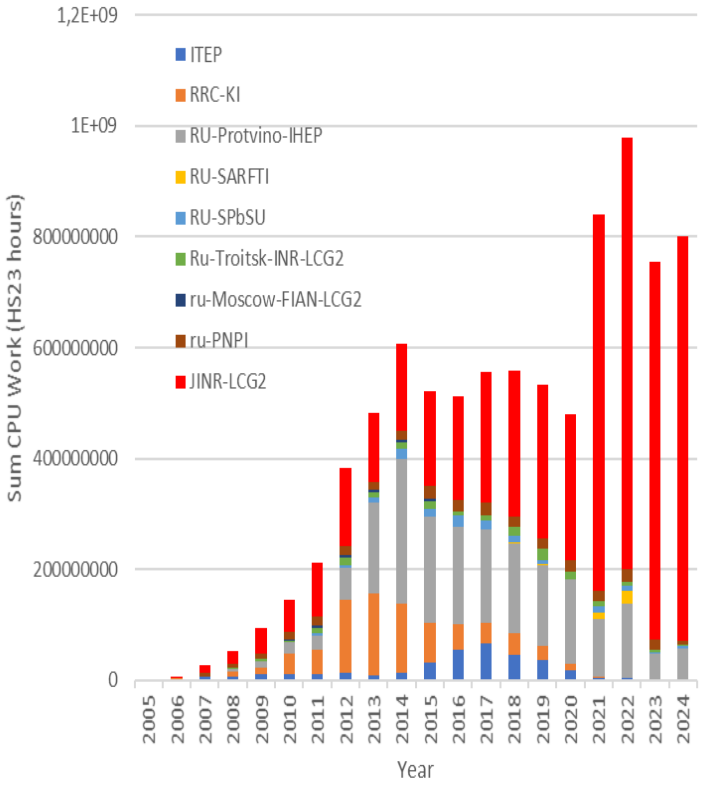
Tier1 CMS 2024

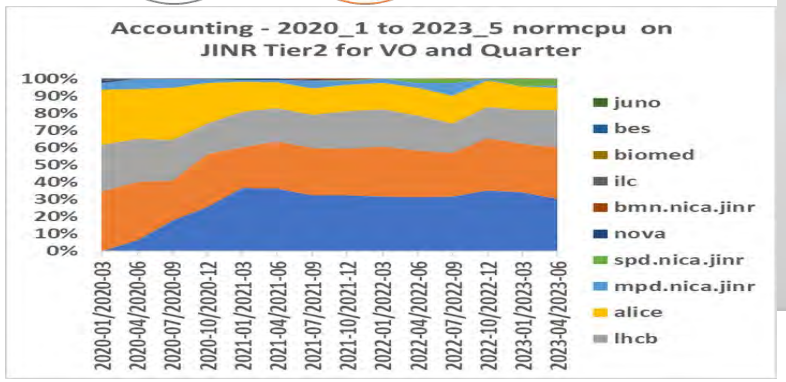
RU-JINR-T1	1,888,913,532	24 %
US-FNAL-CMS	1,665,321,019	21 %
UK-T1-RAL	1,132,299,978	14 %
DE-KIT	1,097,134,332	13 %
FR-CCIN2P3	807,778,212	10 %
ES-PIC	671,291,604	8 %
IT-INFN-CNAF	618,136,609	7 %

Tier2 at JINR

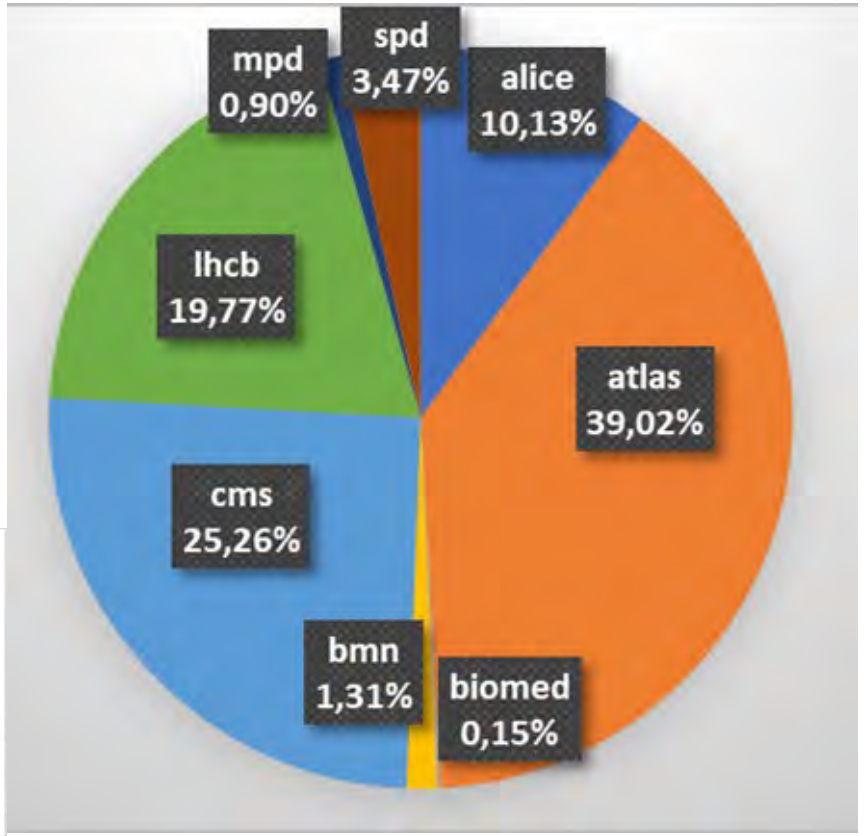
Tier2 at JINR provides computing power and data storage and access systems for the majority of JINR users and user groups, as well as for users of virtual organizations (VOs) of the grid environment (LHC, NICA, FAIR, etc.).

Accounting of RDIG Tier2's and years 2005-2024



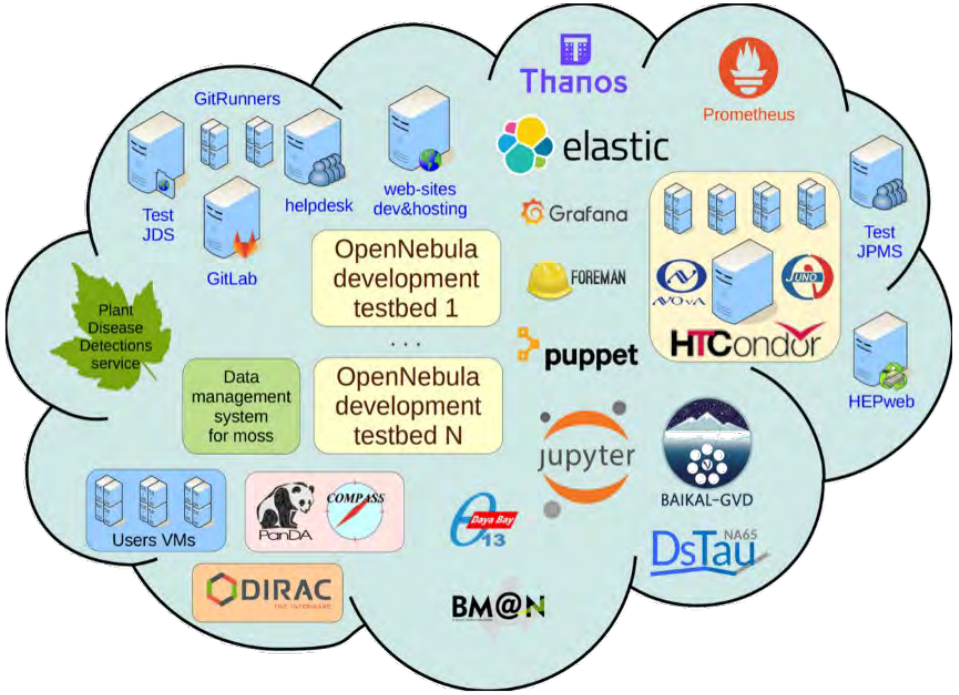


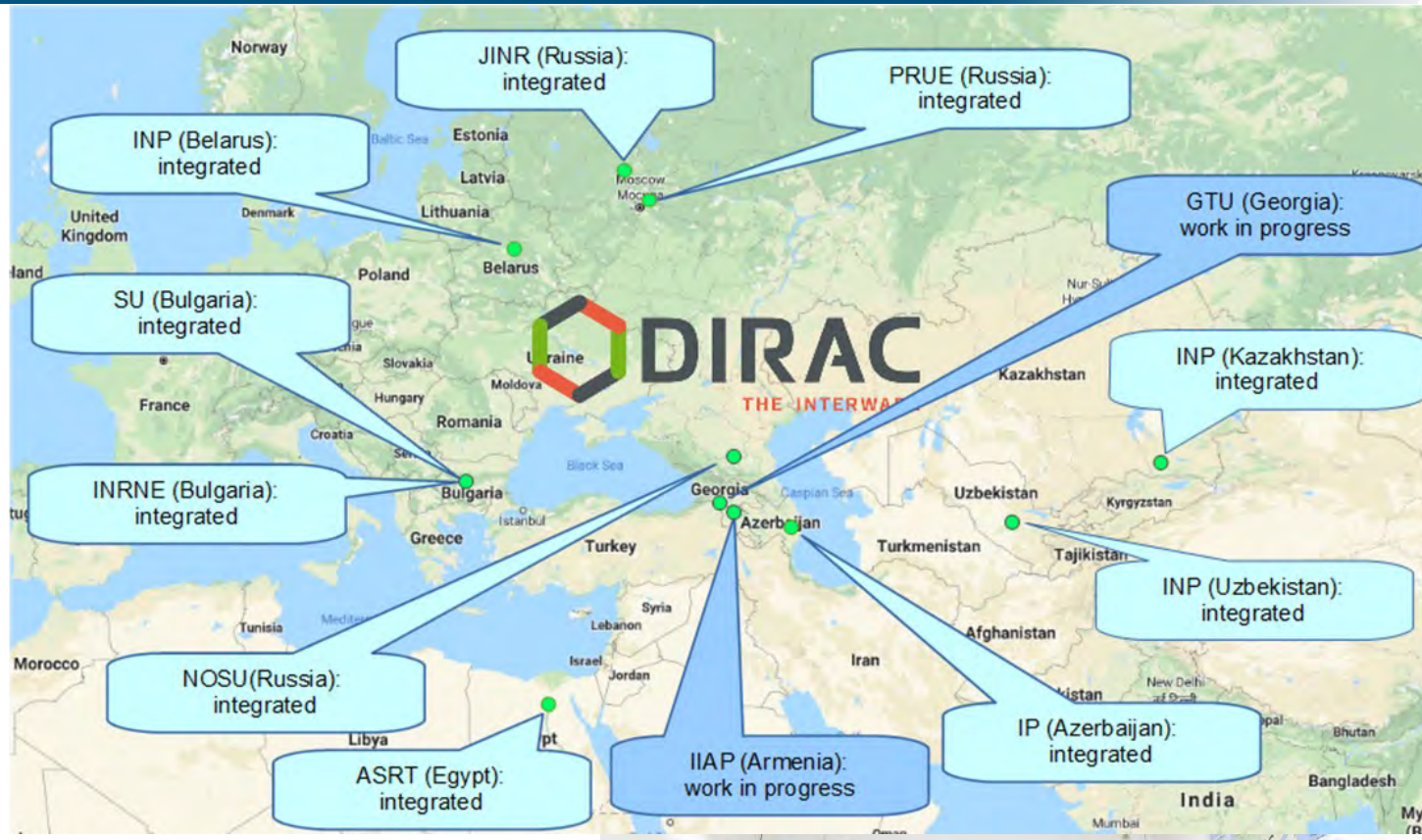
Use of the JINR Tier2 site by virtual organizations within grid projects



Cloud Infrastructure

DIRAC-based distributed information and computing environment (DICE) that integrates the JINR Member State organizations' clouds





- Cloud Platform - OpenNebula
- Virtualization - KVM
- Storage (Local disks, Ceph)
- Total Resources
  5,152 CPU cores; 80 TB RAM;
  5 PB of raw ceph-based storage

- Computational resources for neutrino experiments
- Testbeds for research and development in IT
- COMPASS production system services
- Data management system of the UNECE ICP Vegetation
- Scientific and engineering computing
- Service for data visualization
- VMs for JINR users

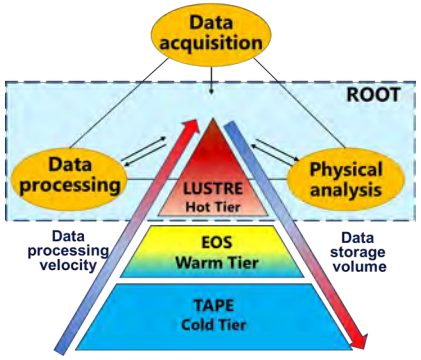
“Govorun” Supercomputer

- Hyper-converged software-defined system
- Hierarchical data processing and storage system (1,6-10-30-100 PB)
- Scalable solution Storage-on-demand
- Total peak performance: 2.2 PFlops DP and 58 Pflops for AI tasks
- GPU component based on NVIDIA Tesla V100+A100+H100
- CPU component based on RSC “Tornado” liquid cooling solutions
- The most energy-efficient center in Russia (PUE = 1.06)
- Storage performance >300 GB/s

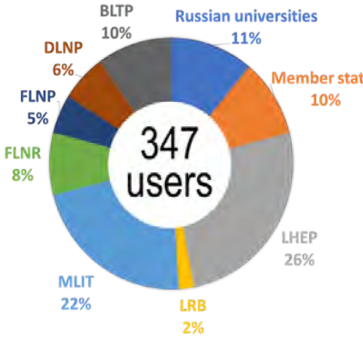
Key projects that use the resources of the SC “Govorun”:

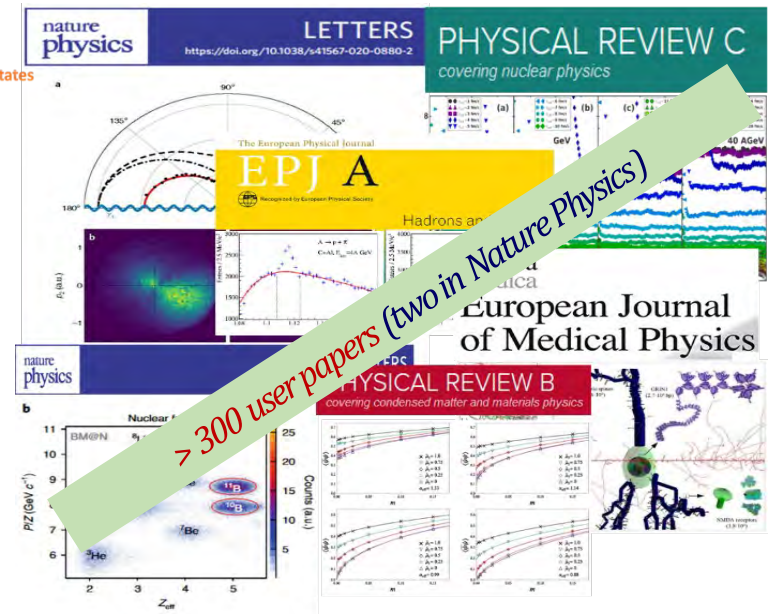
- NICA megaproject,
- calculations of lattice quantum chromodynamics,
- computations of the properties of atoms of superheavy elements,
- studies in the field of radiation biology,
- calculations of the radiation safety of JINR’s facilities.

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



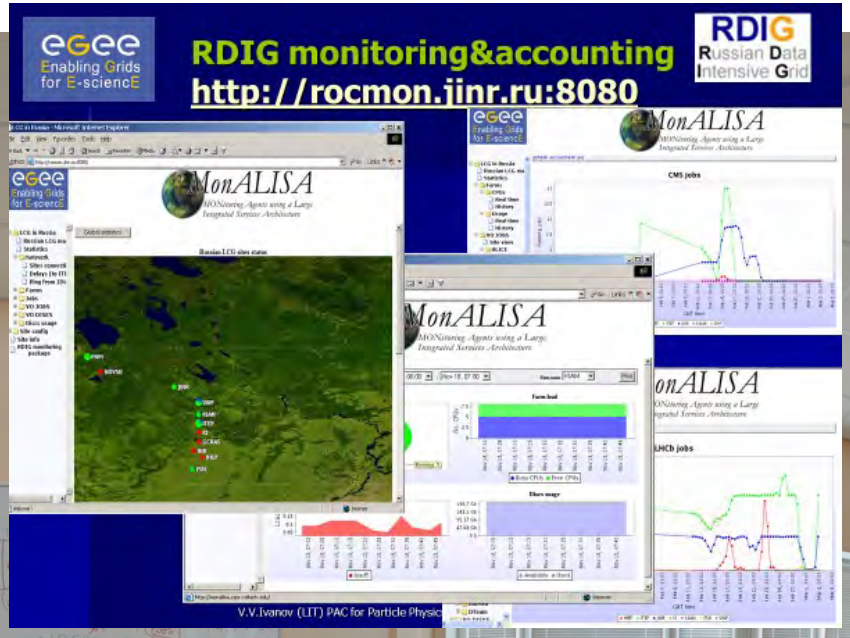
Total number of users : 347 including from the Member States (Armenia, Belarus, Vietnam, Egypt, South Africa)

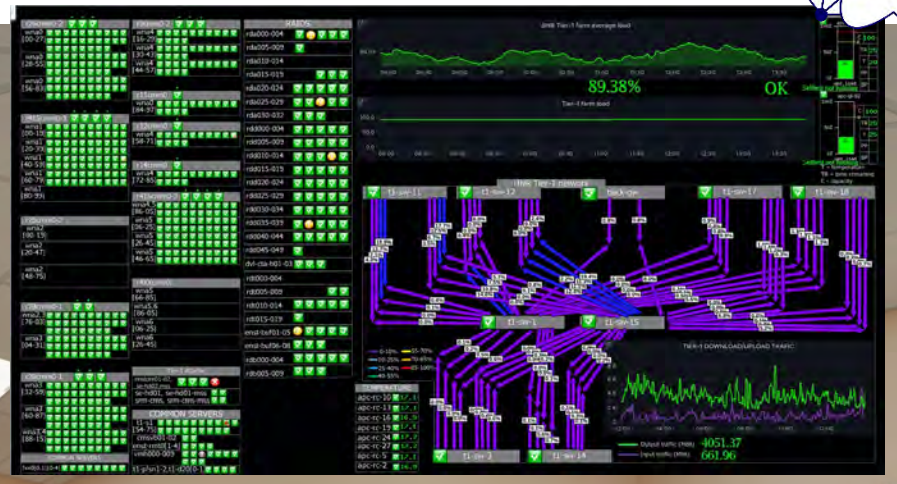




SC "Govorun" is included into a single supercomputer infrastructure based on the National Research Computer Network of Russia (NIKS).

Monitoring


eGee
Enabling Grids for E-sciencE
RDIG monitoring&accounting
http://rocmon.jinr.ru:8080
RDIG
Russian Data Intensive Grid
MonALISA
V.V.Ivanov (LIT) PAC for Particle Physic


89.38%
OK
4051.37
661.96


50.6 PB
2.65 PB
11.7 PB
20000
1.99 PB
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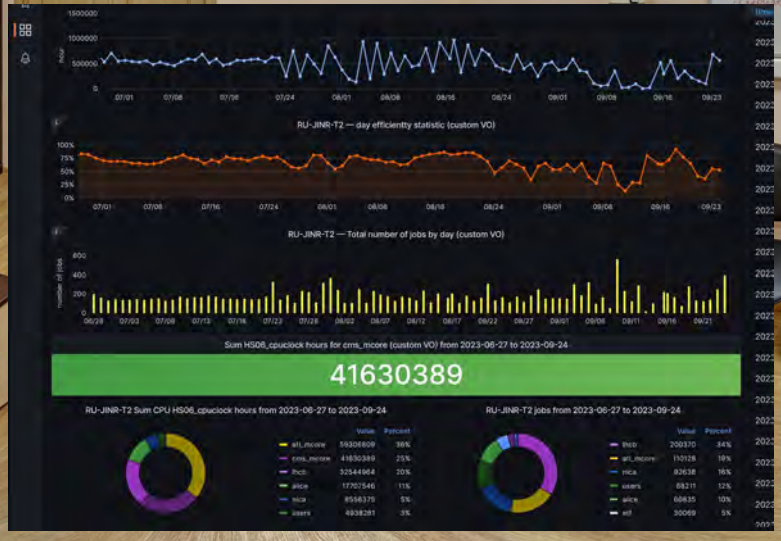
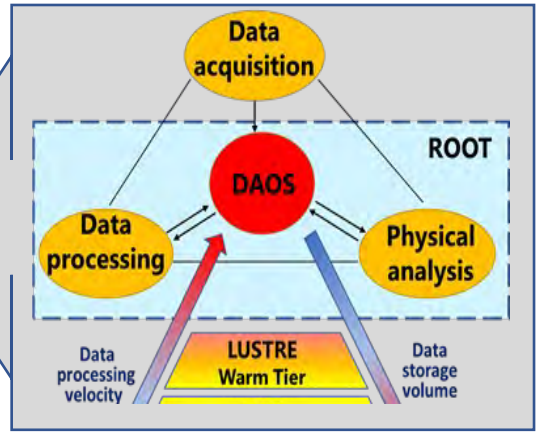
10364
7.51 PB
15680
22.4 PB
4320
5152
60.6 TB
3.84 PB
1.44 PB


RU-JINR-T2 — day efficiently statistic (custom VO)
RU-JINR-T2 — Total number of jobs by day (custom VO)
Sum HS06_cpuclock hours for cms_mcore (custom VO) from 2023-06-27 to 2023-09-24
41630389
RU-JINR-T2 Sum CPU HS06_cpuclock hours from 2023-06-27 to 2023-09-24
RU-JINR-T2 jobs from 2023-06-27 to 2023-09-24

Distributed Multi-layer Data Storage System

- Limited data and short-term storage – to store the OS itself, temporary user files
- AFS distributed global system – to store user home directories and software
- dCache is traditional for the MICC grid sites – to store large amounts of data (mainly LHC experiments) for the middle-term period
- EOS is extended to all MICC resources – to store large amounts of data for the middle-term period. At present, EOS is used for storage by BM@N, MPD, SPD, BaikalGVD, etc.
- Tape robotic systems – to store large amounts of data for the long-term period. At present, for CMS. BM@N, MPD, SPD, JUNO – in progress.



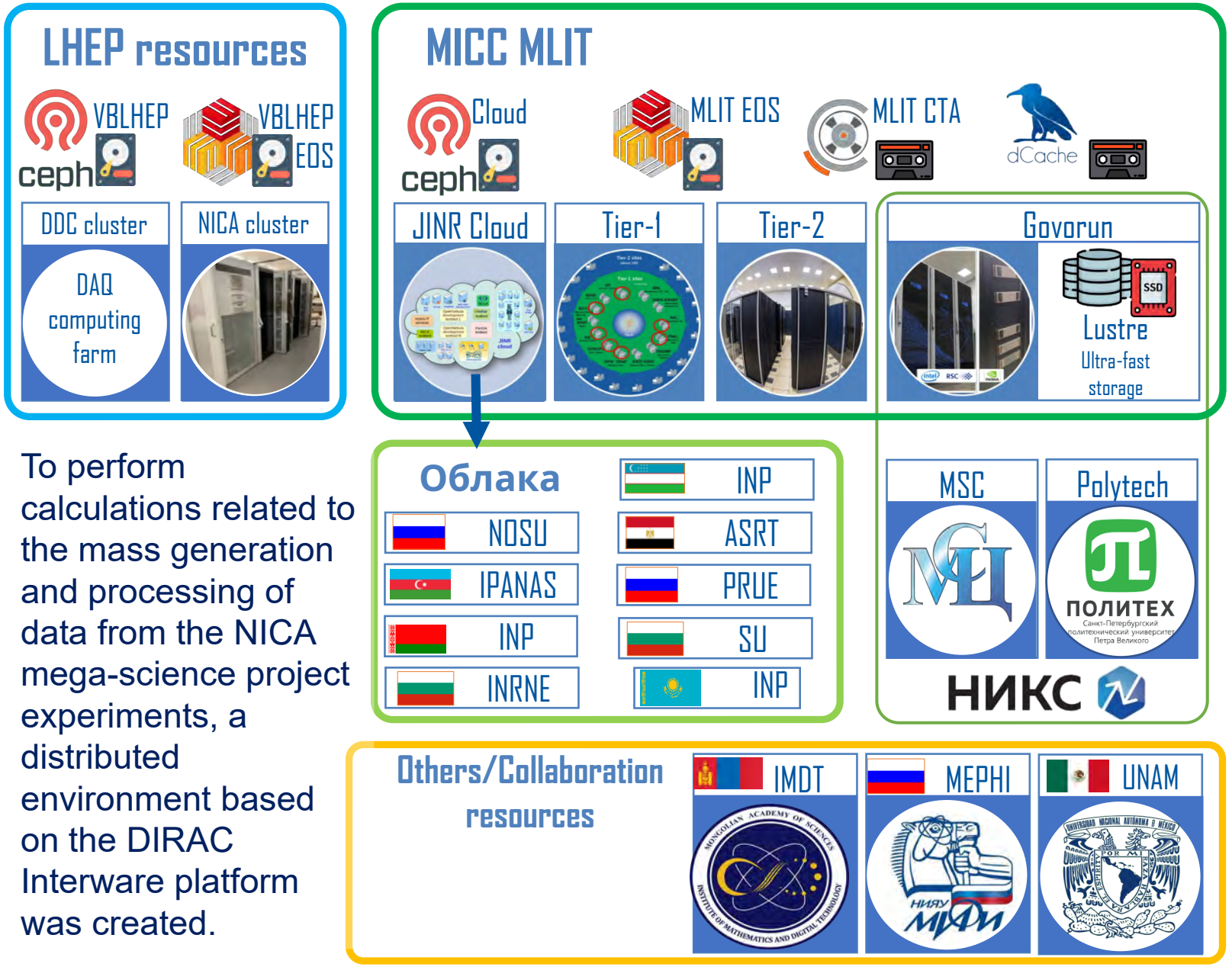
A special hierarchical data processing and storage system with a software-defined architecture was developed and implemented on the “Govorun” supercomputer.

According to the speed of accessing data, there are the following layers:

- ✓ very hot data (DAOS (Distributed Asynchronous Object Storage)),
- ✓ the most demanded data (fastest access),
- ✓ hot data,
- ✓ warm data (LUSTRE).

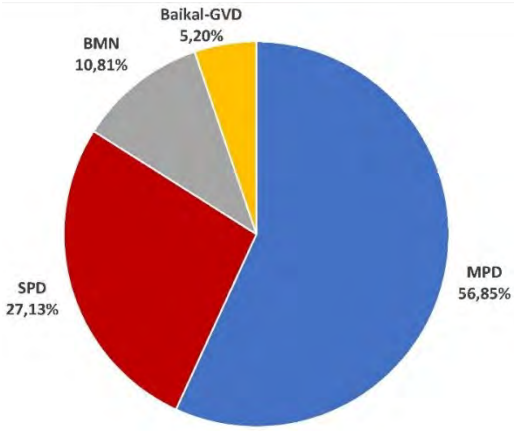
Ускорительный комплекс NICA

DIRAC-based distributed heterogeneous environment

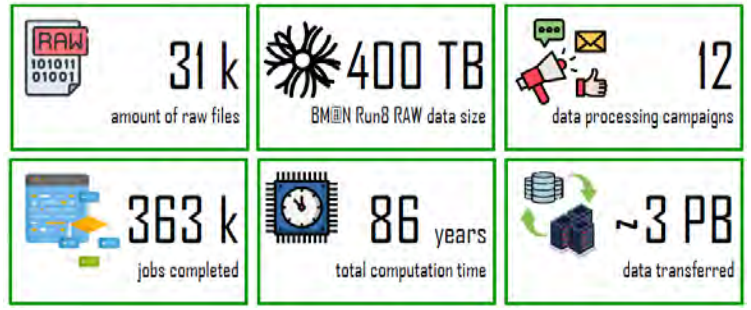


To perform calculations related to the mass generation and processing of data from the NICA mega-science project experiments, a distributed environment based on the DIRAC Interware platform was created.

DIRAC is employed to solve the tasks of collaborations of all three experiments at the NICA accelerator complex, as well as of the Baikal-GVD neutrino telescope.



In 2023, for the first time at JINR, the complete processing of raw data from the 8th run of the BM@N experiment was performed on the distributed heterogeneous computing infrastructure integrated using the DIRAC platform.

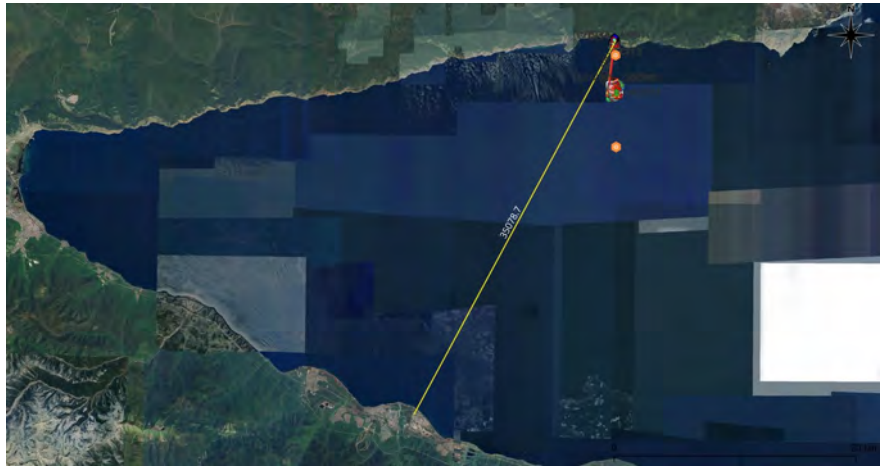


Summary statistics of using the DIRAC platform for BM@N Run 8 data processing

Глубоководный нейтринный телескоп Baikal-GVD (Gigaton Volume Detector)

Глубоководный нейтринный телескоп Baikal-GVD (Gigaton Volume Detector), строящийся в настоящее время на озере Байкал, при достижении объема в 1км3 представит собой важнейший компонент глобальной многоканальной астрономической сети, дополнив нейтринную обсерваторию IceCube, таким образом обеспечив эффективное покрытие южной небесной полусферы.

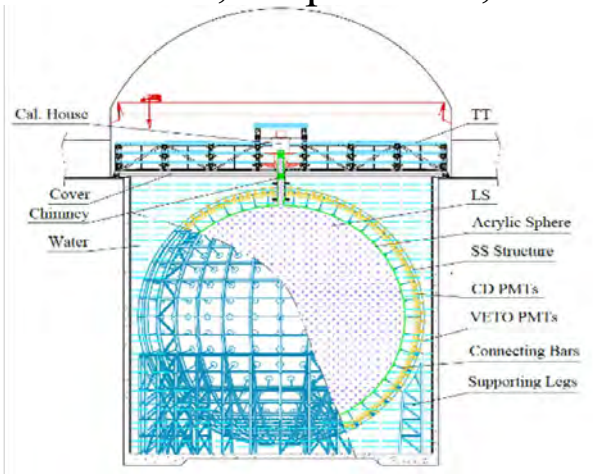
Ресурсы для проекта в ОИЯИ: более 2000 ядер, около 2 ПБ
дисковое хранилище, 2 ПБ – ленточная библиотека



В данный момент суммарный поток экспериментальных данных находится в пределах 100 МБит/с, но с учётом роста установки в течение трех ближайших лет для комфортной работы потребуется скорость передачи 1 ГБит/с.

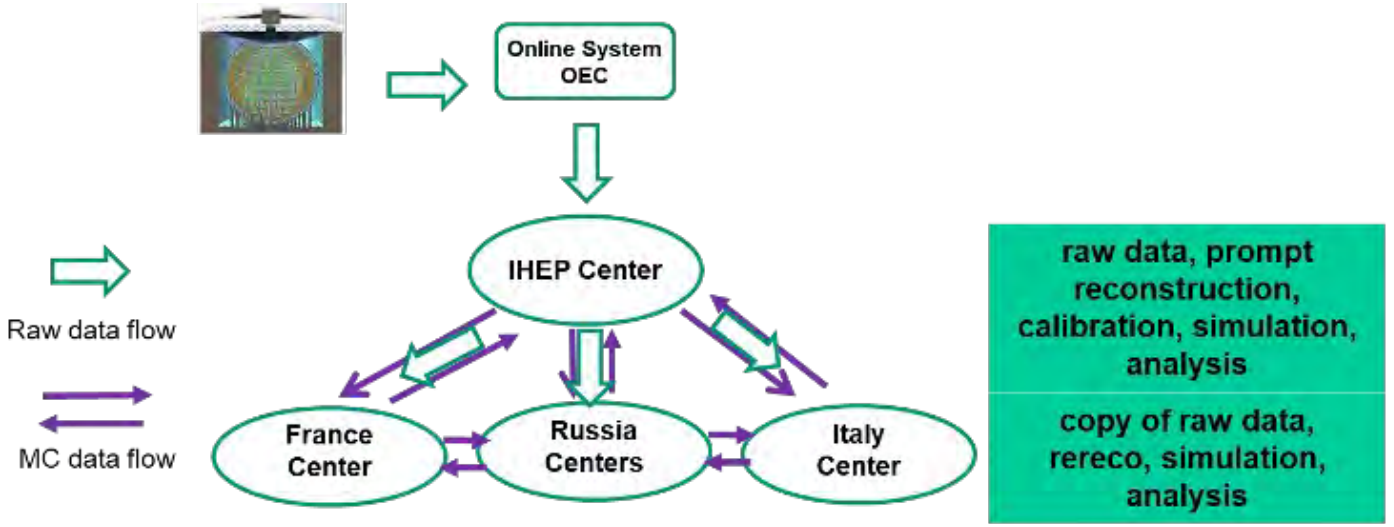
Эксперимент JUNO в Китае

Эксперимент JUNO — это многоцелевая нейтринная обсерватория с обширной программой исследований в области нейтринной физики и астрофизики. Проект нацелен на изучение нейтрино в широком диапазоне энергий, включая солнечные, сверхновые, атмосферные, геонейтрино, а также проводит поиск протонного распада и экзотических явлений.



Вычислительные ресурсы для JUNO в ОИЯИ:
– 2000 + 1700 ядер

Детектор JUNO



Четыре центра обработки данных — ИФВЭ АН КНР, ОИЯИ, IN2P3 и CNAF — обеспечивают хранение данных и совместную обработку. В качестве центра Tier 0 IHEP сохраняет все данные, включая данные Монте-Карло (MC) и RAW

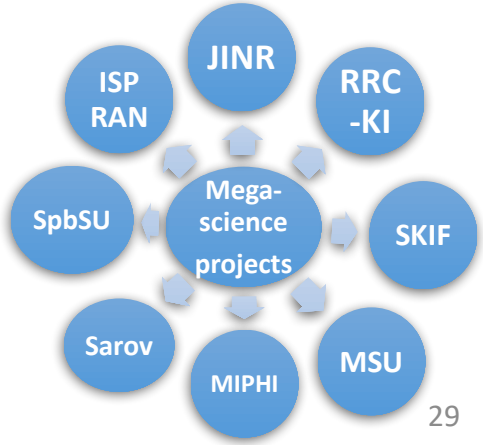
В ближайшие 5 лет минимально необходимая пропускная способность каналов передачи данных для центров Tier-1 на текущий момент оценивается в 2,5 Гбит/с.

Прогноз объемов хранения данных JUNO по типу хранилища (ПБ) в центрах Tier-1

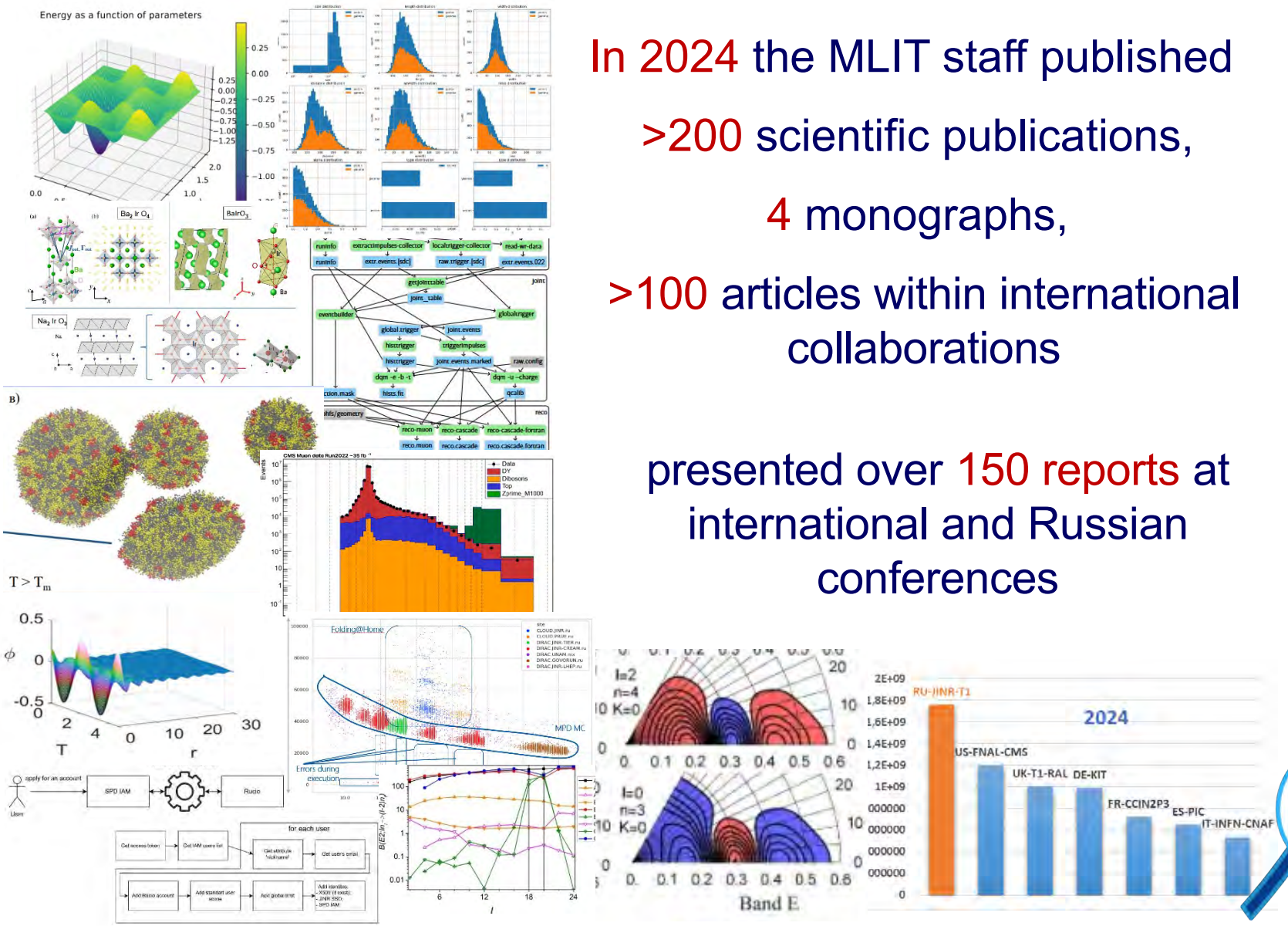
Тип хранилища	2025	2026	2027	2028	2029
Ленточное	2.79	5.83	11.17	13.96	19.54
Дисковое	2.98	6.26	7.49	7.49	7.49

Creation of a consortium for IT support of large-scale research infrastructure

- In Russia, a program of large-scale scientific projects is being implemented, the most important part of which is the development of distributed heterogeneous computer systems (including systems with parallelism) for processing, storing, analyzing experimental data, development and implementation of effective methods, algorithms and software for modeling physical systems, mathematical processing and analysis of experimental data, development of methods of machine learning, artificial intelligence, quantum computing.
- To solve this large-scale task, it is necessary to develop a distributed computer infrastructure that unites key scientific and educational institutes participating in mega-science projects - RDIG-M. The consortium created on the basis of JINR, NRC Kurchatov Institute, ISP RAS should become the core for IT support of the research infrastructure of the "mega-science" class.



Methods, Algorithms and Software



In 2024 the MLIT staff published

>200 scientific publications,

4 monographs,

>100 articles within international collaborations

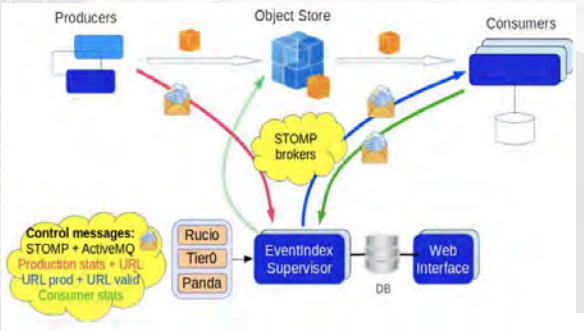
presented over 150 reports at international and Russian conferences

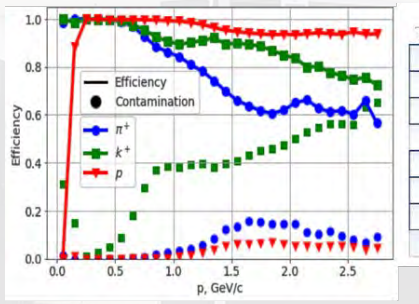
- Numerical modeling of complex physical systems
- Experimental data processing and analysis
- Big Data
- Machine and Deep learning
- Computer algebra
- Quantum computing

Методы, алгоритмы и ПО для обработки и анализа данных

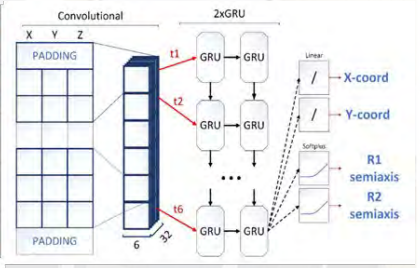
Моделирование физических процессов и установок	Реконструкция и анализ данных	Программная среда для экспериментов
Моделирование физических событий	Реконструкция траекторий частиц	Модели обработки и анализа данных
GEANT-моделирование экспериментальных установок	Идентификация частиц	Модель данных
	Реконструкция физических процессов	Программные платформы и системы
	Анализ экспериментальных данных	Развитие и сопровождение БД
		Визуализация событий

Основная стратегия применение общих для различных экспериментов решений и методик при создании ПО для моделирования, реконструкции и анализа данных.

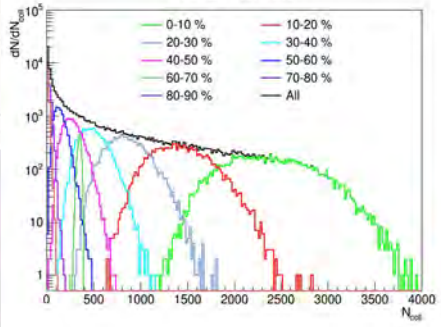


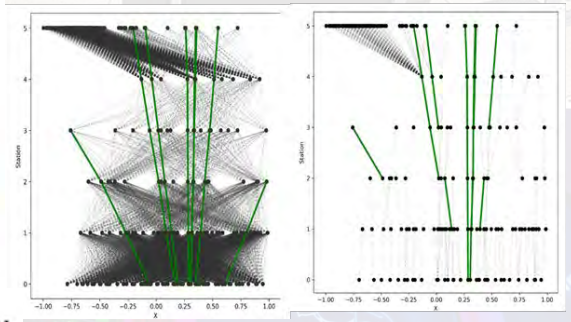


Gradient-boosted decision trees for PID in MPD

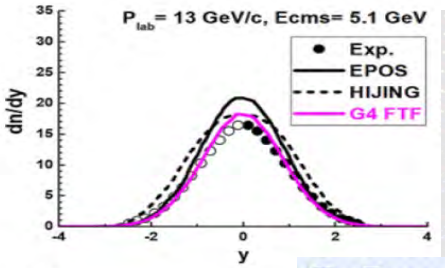


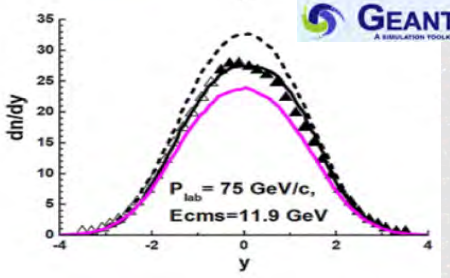
Deep GNNs for solving tracking problems in BM@N, BESIII, SPD



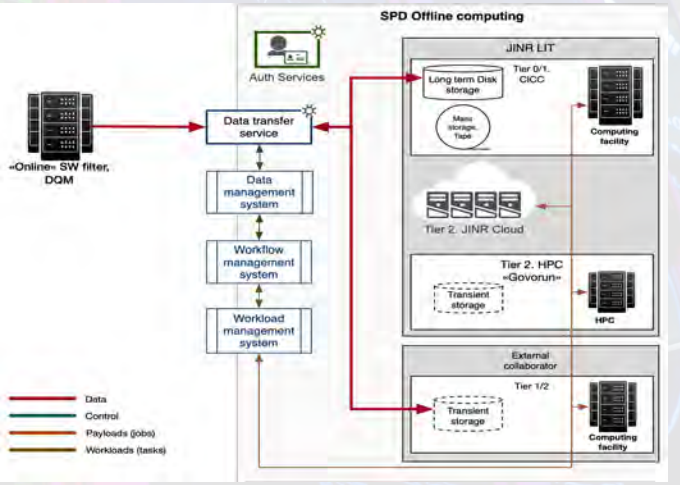


Graph Neural Networks for Tracking



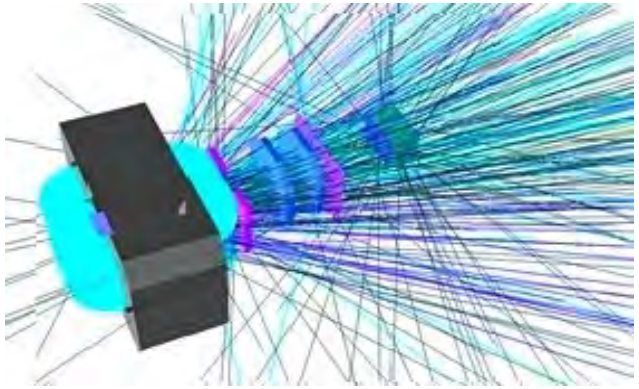


GEANT4

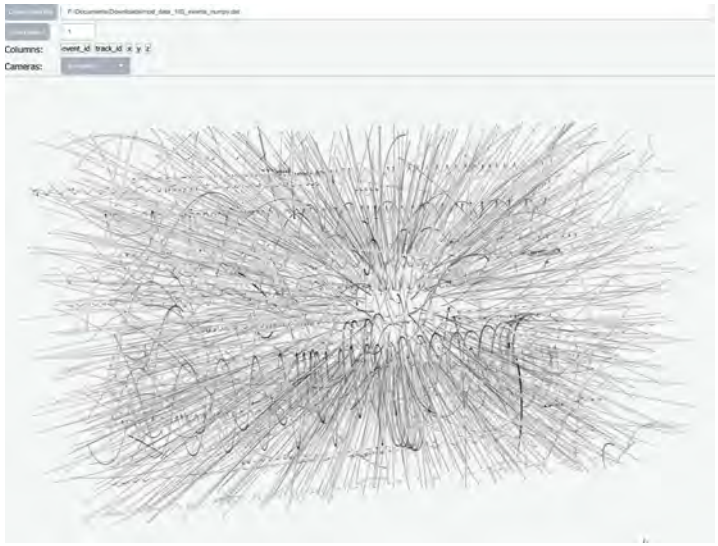


- разработка математических методов, включая ML/DL, и программного обеспечения для моделирования физических процессов и экспериментальных установок, обработки и анализа экспериментальных данных в области физики элементарных частиц, ядерной физики, физики нейтрино, конденсированного состояния сред, радиобиологии и т. д.
- разработка, поддержка и эксплуатация программных комплексов для распределенной обработки и анализа экспериментальных данных, а также информационных систем для поддержки исследований в ОИЯИ и других мировых центрах.

ML методы для современных экспериментов ФВЭ



Эксперимент BM@N. Стриповые GEM детекторы внутри магнита



Трековый детектор TPC внутри магнита MPD. Иллюстрация смоделированного события столкновения пучков ионов золота, создающее тысячи треков.

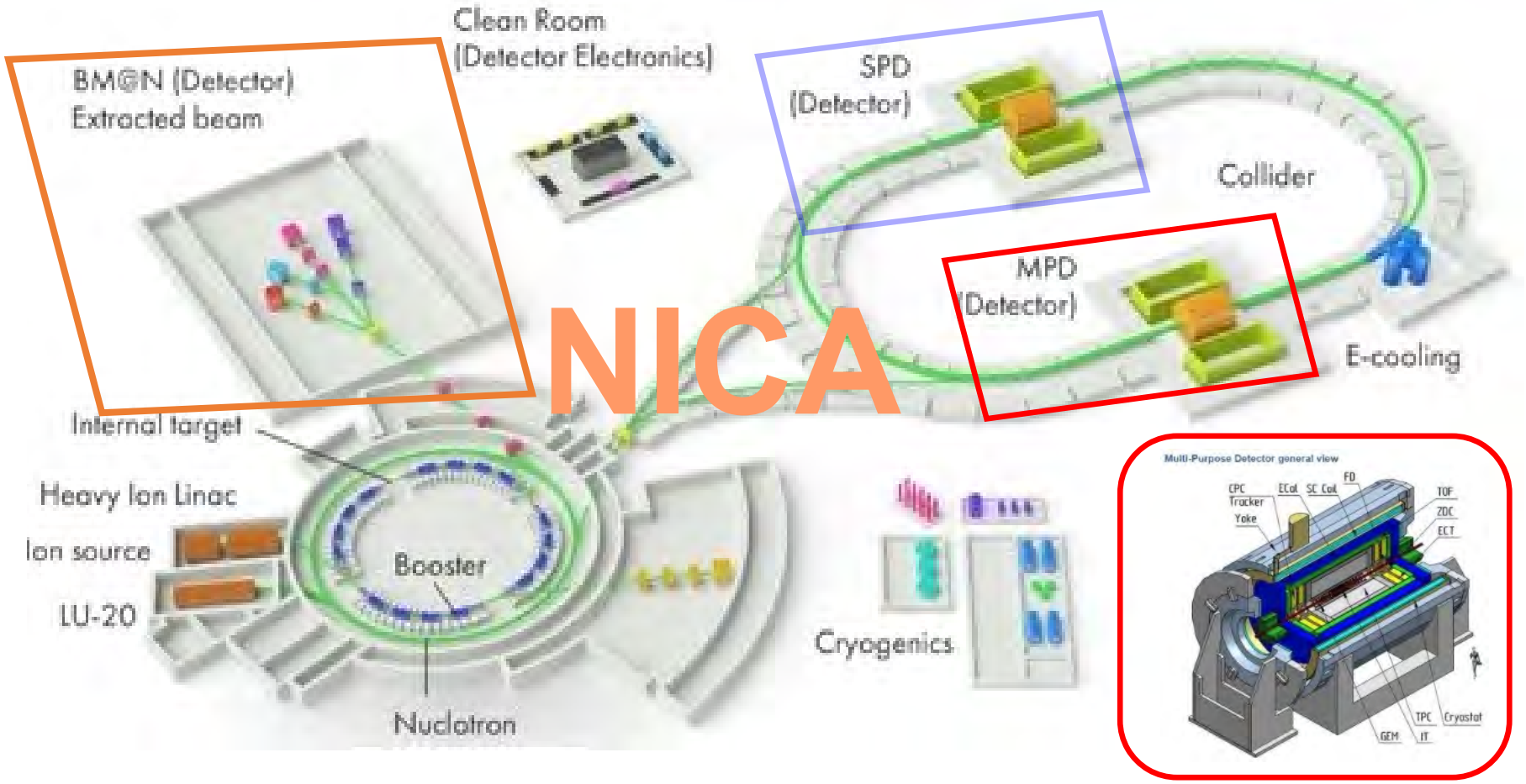


Схема ускорительного комплекса NICA с экспериментами MPD, SPD, BM@N

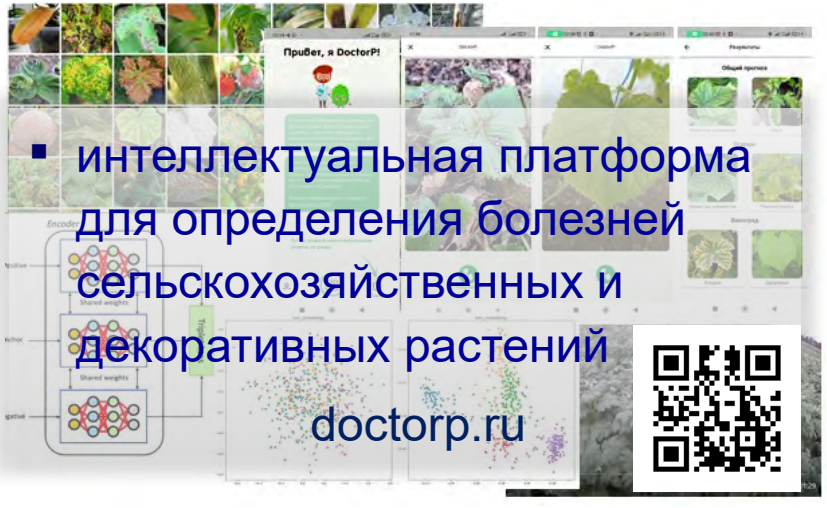
Задачи: реконструкция событий по данным измерений в трековых и других детекторах.

Радиобиология и науки о жизни

Применение накопленного опыта к различным классам задач!

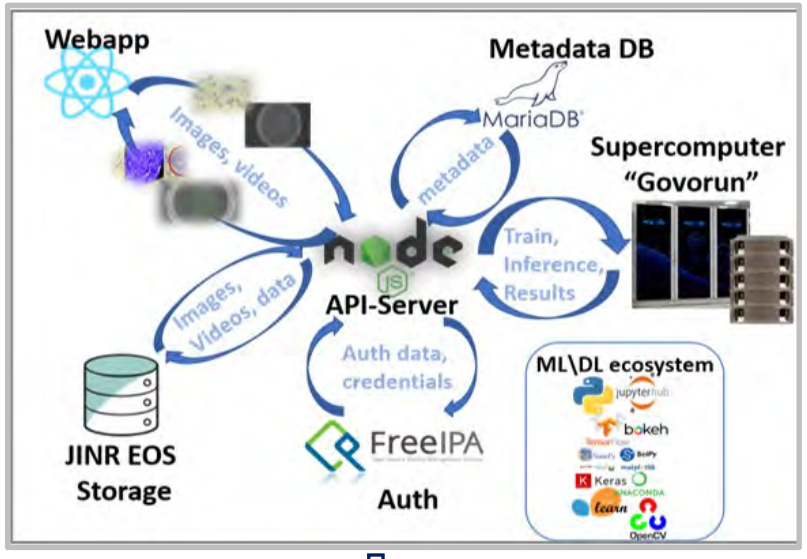
- Интеллектуальная платформа мониторинга окружающей среды

moss.jinr.ru



- интеллектуальная платформа для определения болезней сельскохозяйственных и декоративных растений

doctorp.ru



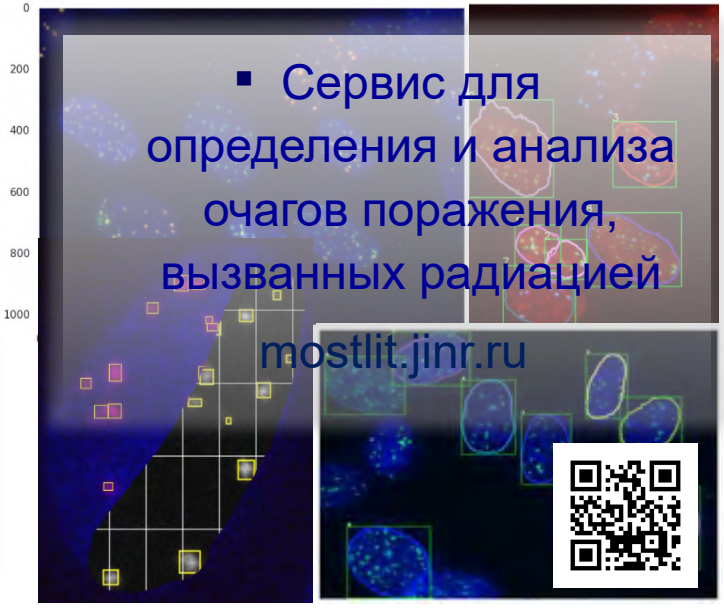
- Информационная система для задач радиобиологии

bio.jinr.ru

хранение,быстрый доступ и анализ данных радиобиологических экспериментов

ML/DL/HPC экосистема

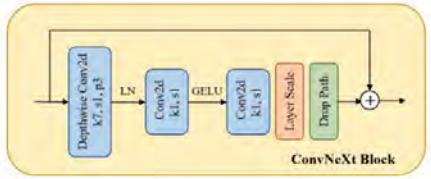
- ML/DL технологии
- Современные IT-решения для хранения, обработки и визуализации данных
- Статистический анализ

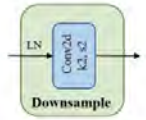


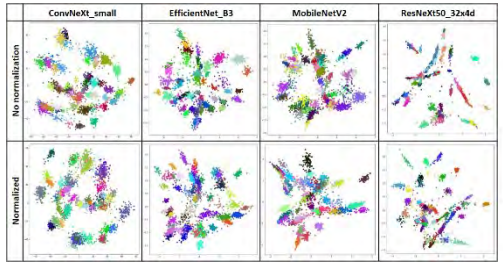
- Сервис для определения и анализа очагов поражения, вызванных радиацией

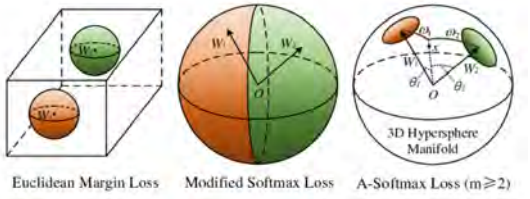
mostlit.jinr.ru

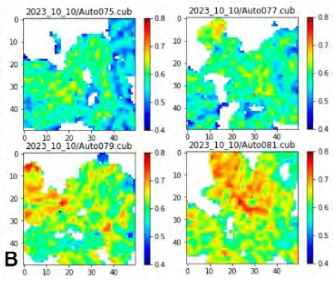
Методы глубокого обучения для решения различных проблем в сельском хозяйстве









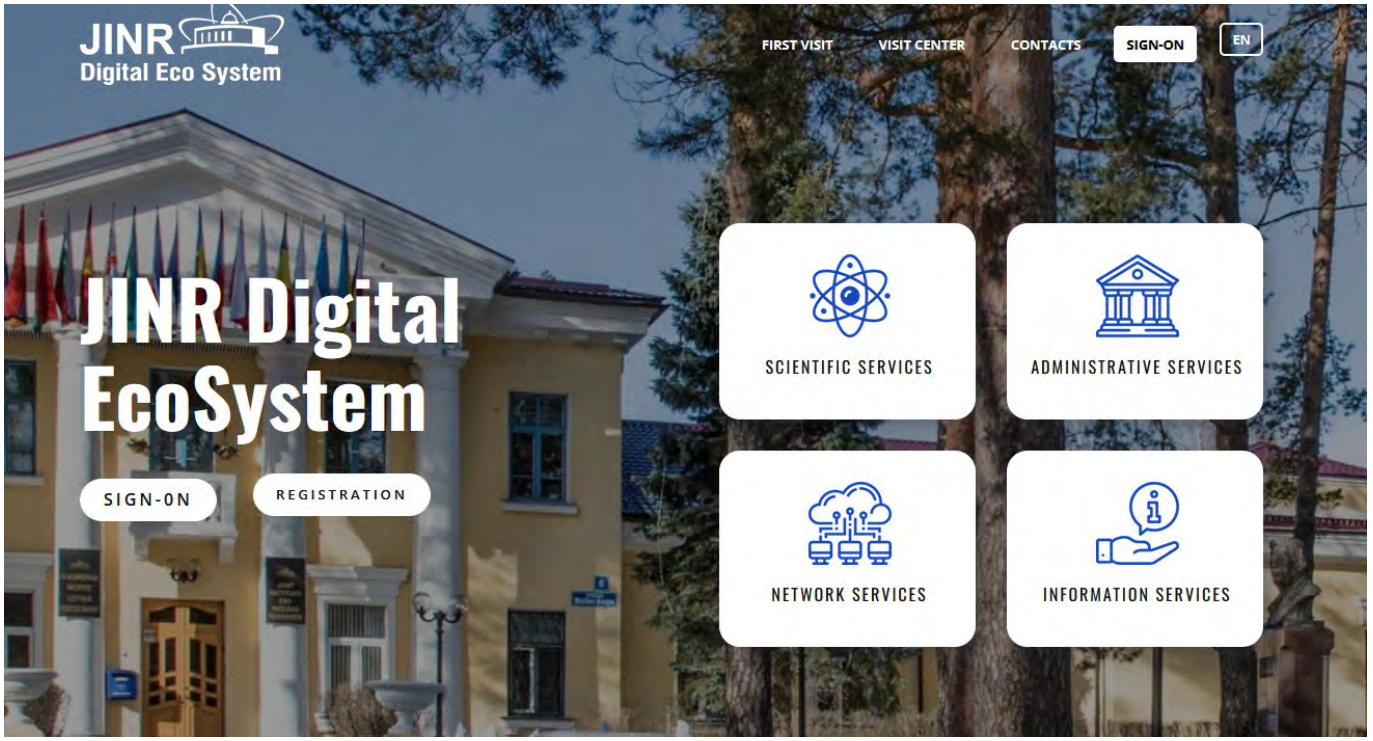


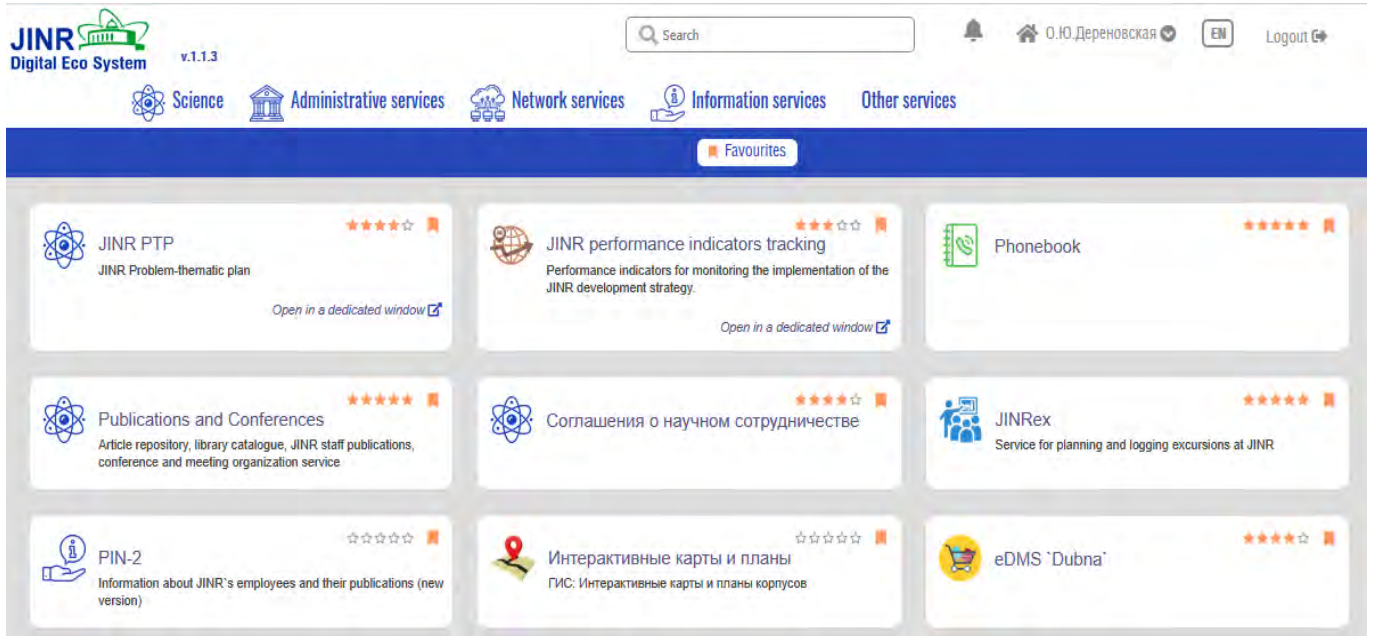
Представленное исследование фокусируется на обнаружении болезней растений с помощью ИИ для повышения эффективности сельского хозяйства и продовольственной безопасности. Платформа DoctorP, разработанная на основе этой работы, использует передовые методы для классификации 68 классов болезней растений, вредителей и их последствий. Глубокие нейронные сети с современной архитектурой были предложены для работы в условиях ограниченных данных обучения. Доступная через веб, мобильные приложения и API, платформа обработала более 250 000 пользовательских запросов и применялась в академических программах и промышленных проектах.

Кроме того, были предложены методы обнаружения болезней растений на ранней стадии с использованием гиперспектральной визуализации.

Автоматизированный мониторинг теплиц находится в стадии разработки с использованием автономных роботизированных платформ для отслеживания растений и создания цифровых двойников.

Исследование интегрирует решения ИИ для снижения затрат, улучшения мониторинга и поддержки устойчивого земледелия.

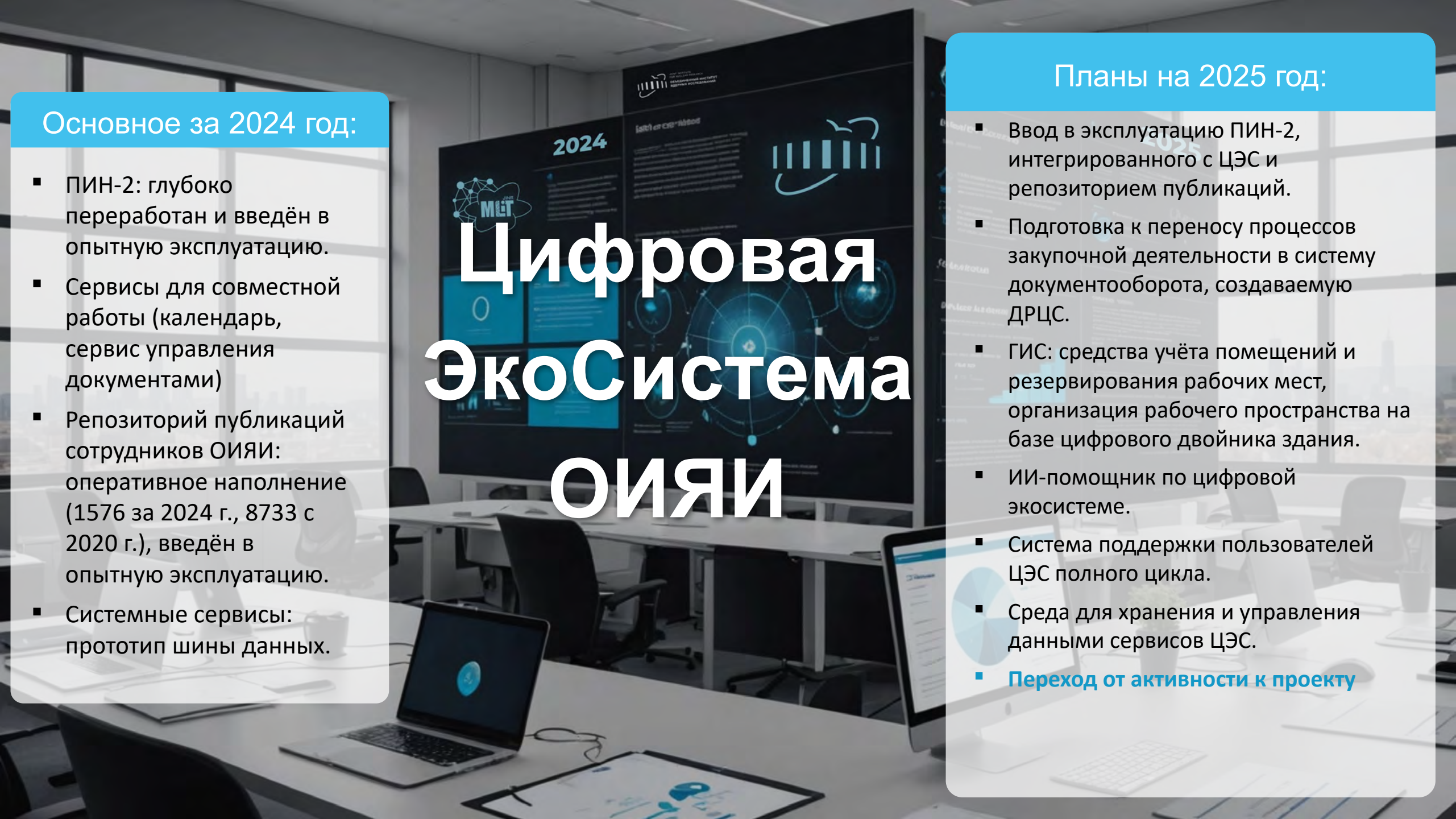




JINR Digital Ecosystem

a single window into the JINR digital environment

- integration of existing and prospective services for **supporting scientific, administrative and social activities**, as well as maintenance of the Institute's engineering and IT infrastructure.
- Integrated Personal Account of a JINR Employee
- Notifications in the Personal Account
- Some resources are available to unregistered users
- Relevance. Information is updated promptly and regularly by service owners
- Convenient interface for service administrators
- Supports bilingualism: Russian and English
- Mobile version of the system



Цифровая ЭкоСистема ОИЯИ

Основное за 2024 год:

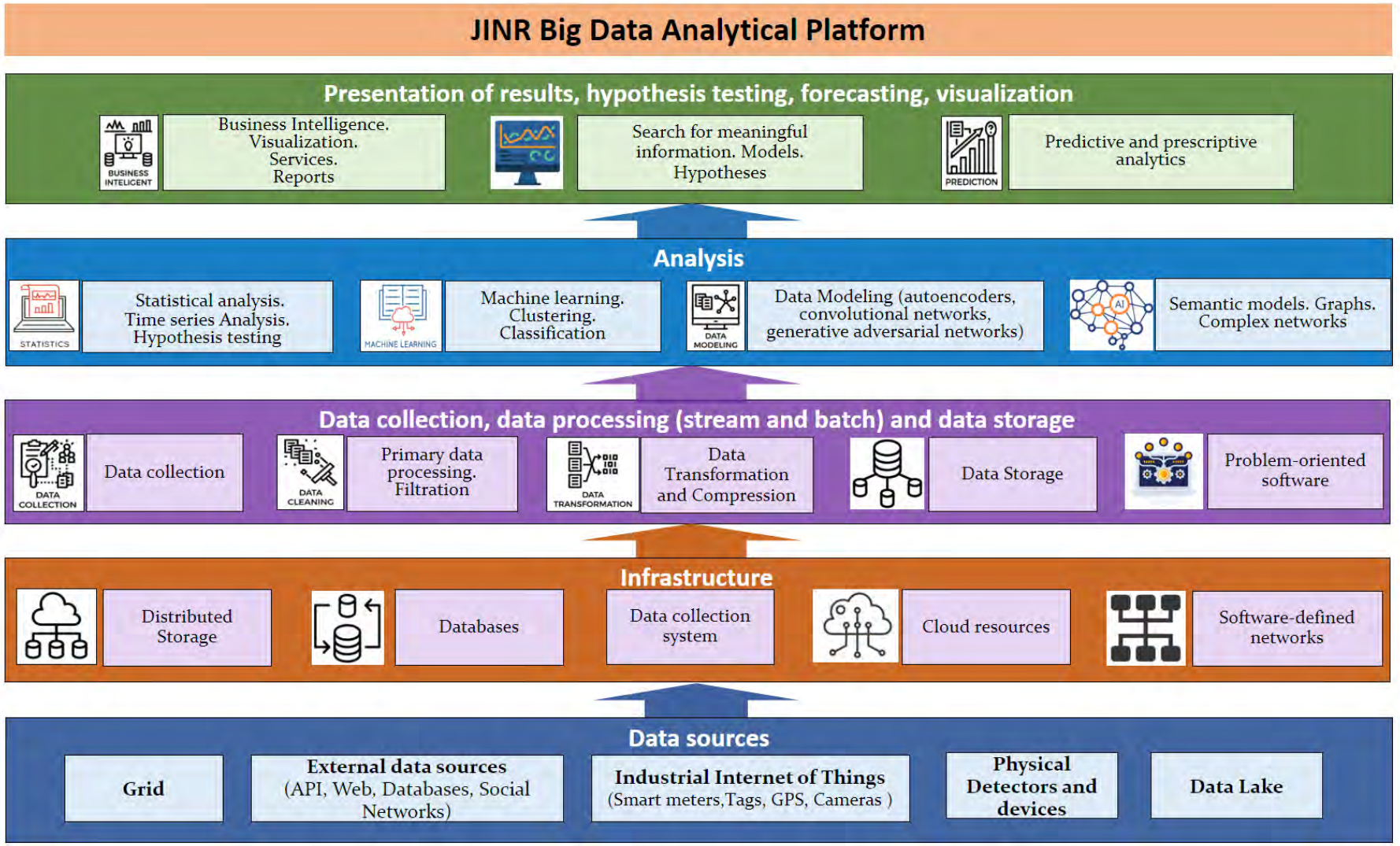
- ПИН-2: глубоко переработан и введён в опытную эксплуатацию.
- Сервисы для совместной работы (календарь, сервис управления документами)
- Репозиторий публикаций сотрудников ОИЯИ: оперативное наполнение (1576 за 2024 г., 8733 с 2020 г.), введён в опытную эксплуатацию.
- Системные сервисы: прототип шины данных.

Планы на 2025 год:

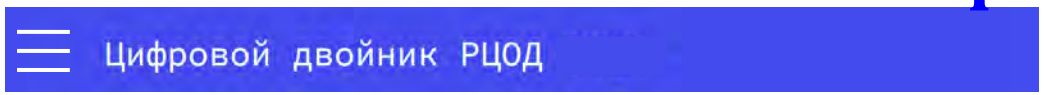
- Ввод в эксплуатацию ПИН-2, интегрированного с ЦЭС и репозиторием публикаций.
- Подготовка к переносу процессов закупочной деятельности в систему документооборота, создаваемую ДРЦС.
- ГИС: средства учёта помещений и резервирования рабочих мест, организация рабочего пространства на базе цифрового двойника здания.
- ИИ-помощник по цифровой экосистеме.
- Система поддержки пользователей ЦЭС полного цикла.
- Среда для хранения и управления данными сервисов ЦЭС.
- **Переход от активности к проекту**

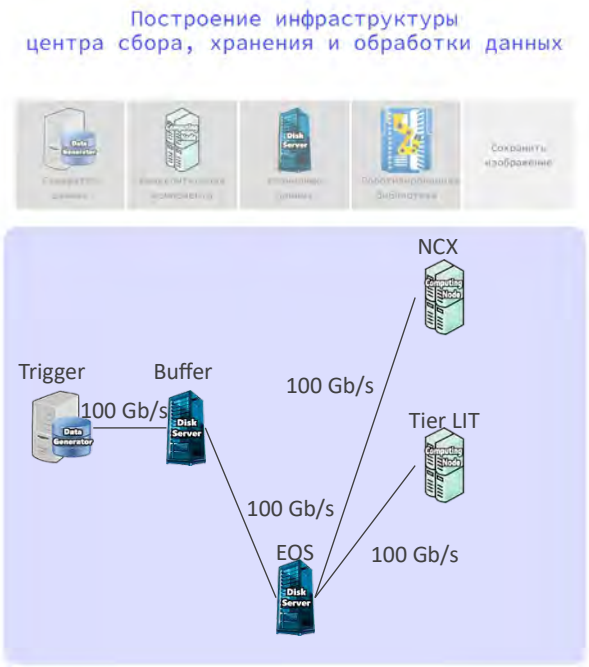
Methods of Artificial Intelligence and Big Data Analytics

- *Bringing best of Big Data approaches to JINR practices*
- *Providing the Big Data infrastructure for users*



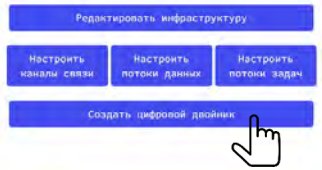
Software Complex for Creating Digital Twins of Distributed Data Acquisition, Storage and Processing Centers

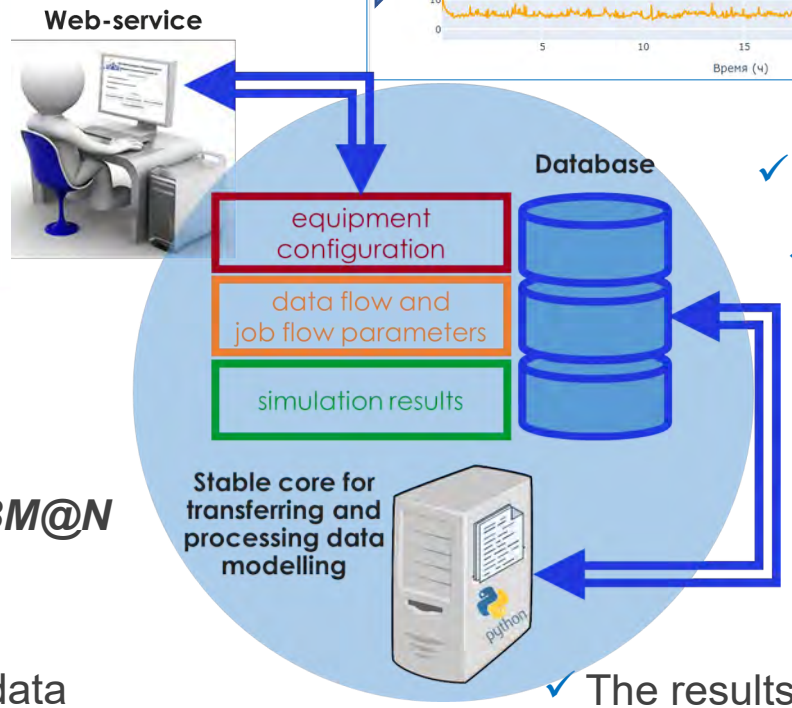




Application examples for the NICA complex

- Creating the digital twin of the computing infrastructure of the ***BM@N experiment***.
- Creating the digital twin of the computing system of the online data filter of the ***SPD experiment***.





Specificities

- ✓ Flexibility.
- ✓ Important functional parameters of distributed centers are taken into account:
  - equipment characteristics;
  - the characteristics of data flows and jobs;
  - the probabilities of failures and changes in the equipment performance and other processes occurring in the system.
- ✓ The results of the digital twin's work differ from the results of the existing distributed center by no more than 20%.

Образовательная траектория подготовки ИТ-специалистов

JINR School of Information Technology

for Russian speaking students

Involving young specialists in solving tasks that face JINR using high-performance and distributed computing, data analysis methods and algorithms, state-of-the-art information technologies

Stage 1

Autumn School

acquaintance with the directions of JINR scientific research

Stage 2

Spring School

presentation the results of joint work with the Institute's specialists

IT SCHOOL JINR

Школа по информационным технологиям ОИЯИ

7-11 октября 2024

58 студентов из Российских университетов

IT SCHOOL
JINR

ОСЕННЯЯ ШКОЛА

по информационным технологиям ОИЯИ

6 - 10 Октября **2025**

JINR

MSU branch in Dubna

Training of specialists to work in the field of theoretical and experimental high energy physics, relativistic nuclear physics on the basis of the Joint Institute for Nuclear Research (JINR, Dubna), as well as for applied research and developments that are being carried out in medicine, biology and other fields using nuclear physical methods and information technologies.

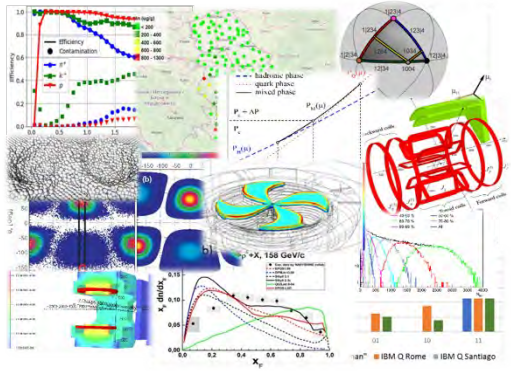
Fields of research in 2024

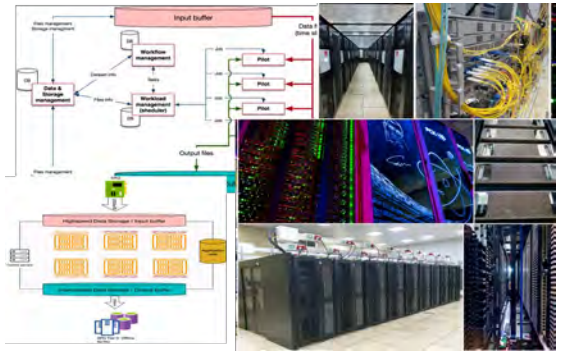
03.04.02 "Physics":
– Master's program "Physics of Elementary Particles"
– Master's program "Fundamental and Applied nuclear physics"

Master's program

Methods and technologies for data processing in heterogeneous computing environments

2025





Mathematical modeling, numerical methods and software packages

Deep machine learning and big data analytics

Computing (software and models) for megascience class projects

MATHEMATICAL MODELING AND COMPUTATIONAL PHYSICS 2024

20–25 Oct 2024
Yerevan, Armenia

More than **150** participants

21 Plenary reports **110** Sessional reports

18 Countries: Armenia, Belarus, Bulgaria, Canada, the Czech Republic, Egypt, France, Georgia, Iran, Kazakhstan, Mongolia, New Zealand, Poland, Romania, Slovakia, Tajikistan, Uzbekistan and a large number of Russian research centers and universities.

Conference Topics:

- Mathematical methods and tools for modeling complex physical systems;
- Mathematical methods in life sciences;
- Modern methods for data processing and analysis in Mega-science projects;
- Machine learning and big data analytics;
- Methods of quantum computing and quantum information processing;
- Numerical and analytical calculations in modern mathematical physics;
- Methods and numerical algorithms in high-energy physics.

GRID'2004 – 204 participants from 8 countries;
GRID'2006 – 173 participants from 8 countries;
GRID'2008 – 211 participants from 20 countries;
GRID'2010 – 198 participants from 21 countries;
GRID'2012 – 243 participants from 22 countries
GRID'2014 – 190 participants from 12 countries;
GRID'2016 – 280 participants from 18 countries;
GRID'2018 – 260 participants from 16 countries;
GRID'2021 – 239 participants from 19 countries;
GRID'2023 – 280 participants from 17 countries;

GRID'2025 – 298 participants from 14 countries
37 plenary and over 135 sessional talks

296 participants

37 Plenary reports
127 Sectional reports

16 Countries:

Armenia
Belarus
Bulgaria
CERN
Egypt
France
Georgia
Iran
Kazakhstan
Mexico
Rwanda
Russian Federation
Romania
South Africa
Taiwan
Uzbekistan

Russia was represented by participants **from 44 universities and research centers**.

Platformix
RSC
ITCost


Joint Institute for Nuclear Research
Meshcheryakov Laboratory of Information Technologies
11th INTERNATIONAL CONFERENCE «DISTRIBUTED COMPUTING AND GRID TECHNOLOGIES IN SCIENCE AND EDUCATION»
GRID'2025
7 — 11 July, Dubna
CONFERENCE TOPICS
1. Distributed Computing Systems, Grid and Cloud Technologies, Storage Systems: architectures, operation, middleware and services
2. High Performance Computing
3. Application software in HTC and HPC
4. Computing for MegaScience Projects
5. Methods and Technologies for Experimental Data Processing
ORGANIZING COMMITTEE
ADVISORY COMMITTEE
PCK
Группа компаний
Hardware and software solutio

Trends in the development of distributed computing for large-scale scientific projects

Development of computer architectures and their integration:

- Peta-ExaFlop scale supercomputers, graphic, quantum, photonic processors as specialized computers around a universal system

- Peta-ExaByte scale distributed hierarchical information storage systems working with common metadata for secure efficient access and reliable storage of information

- cloud-based data centers that provide efficient services to users and support the operation of fog and edge computing systems

- intelligent task management systems in a distributed heterogeneous environment that includes various computer architectures (supercomputers, grid, clouds, clusters, servers, volunteer computing systems)

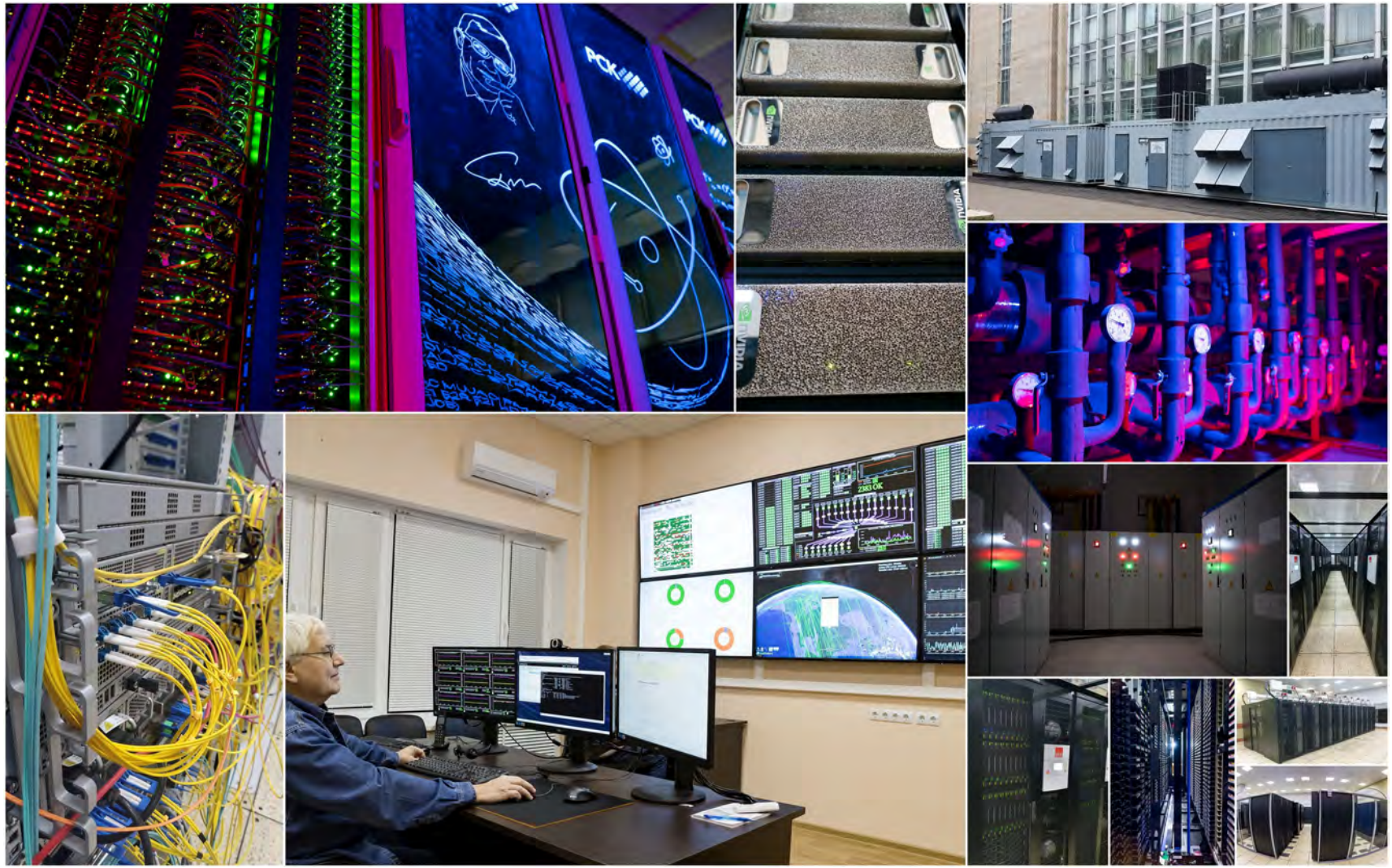
- development of methods, algorithms, platforms, systems of Big Data analytics, intelligent data analysis, ML/DL, artificial intelligence, digital services

- creation of digital twins of experimental setups, distributed computer systems and other complex objects

- training of highly qualified specialists in the field of distributed computing, storage, processing, and analysis of data for scientific projects

JINR

Спасибо за внимание



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