Development of information systems for theoretical and applied tasks on the basis of the HybriLIT platform

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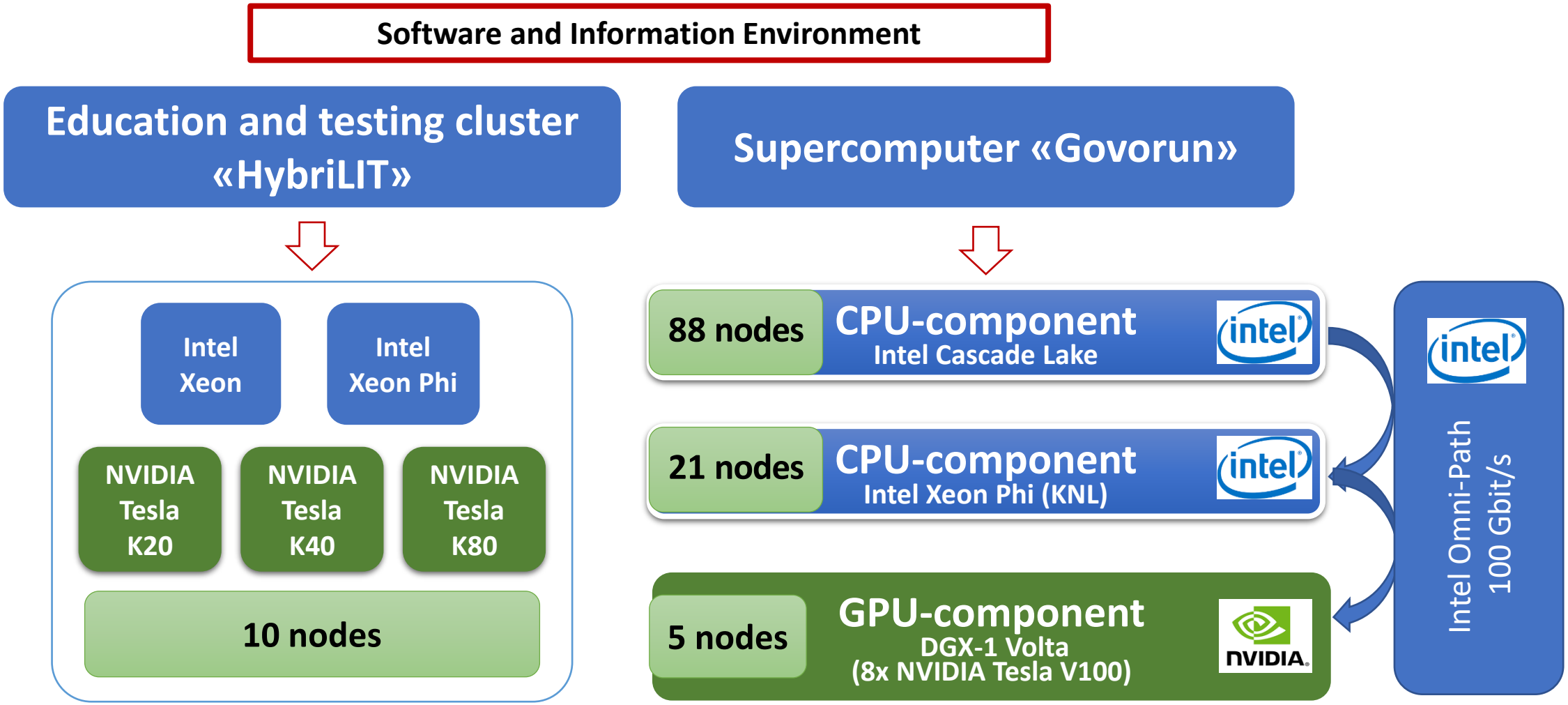
Development of information systems for theoretical and applied tasks on the basis HybriLIT platform

Heterogeneous platform HybriLIT



Development of information systems for theoretical and applied tasks on the basis HybriLIT platform

NVIDIA DGX-1 – is the first system designed specifically for deep learning. The system is based on Volta generation graphics accelerators, which provide a data processing speed comparable with 250 x86 servers.

SC «Govorun» consists of 5 DGX-1 servers with two types of computing processors:
- 2x Intel Xeon E5-2698 v4 20 cores;
- 8x NVIDIA Tesla V100

NVIDIA Tesla V100

Double precision	7.8 Tflops
Single precision	15.7 Tflops
Deep learning	125 Tflops

Development of information systems for theoretical and applied tasks on the basis HybriLIT platform

ML/DL and data analysis ecosystem + JLabHPC

Easy and fast prototyping of ML/DL algorithms in Jupyter Notebook environment

4x GPU Volta V100 is available for learning of convolutional neural networks

Popular frameworks for DL/ML/CV (Tensorflow, Keras, Pytorch, Opencv etc.) are assembled and ready for use.

Large specter of available Python libraries for data analysis and visualization

Specifications:

- GPU: 4x Nvidia Volta V100-SXM2 *NVLink* 32Gb HBM2
- CPU : 2x Intel Xeon Gold 6148 CPU @ 2.40GHz 20 Cores/40 Threads
- RAM: 512 GB DDR4 2666MHz
- SSD: 2*240 GB

intel NVIDIA

Development of information systems for theoretical and applied tasks on the basis HybriLIT platform

SSH — MODULES — Compilers — SLURM

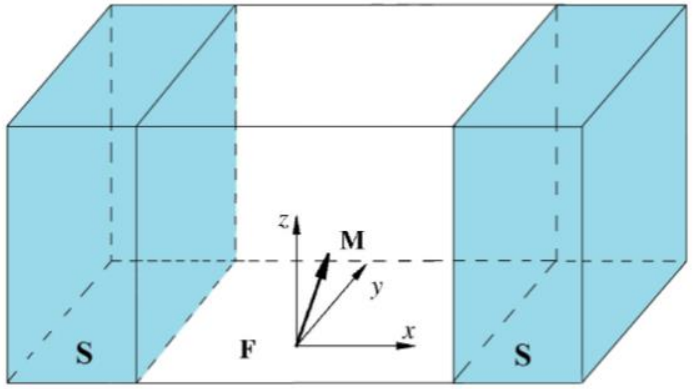
Users

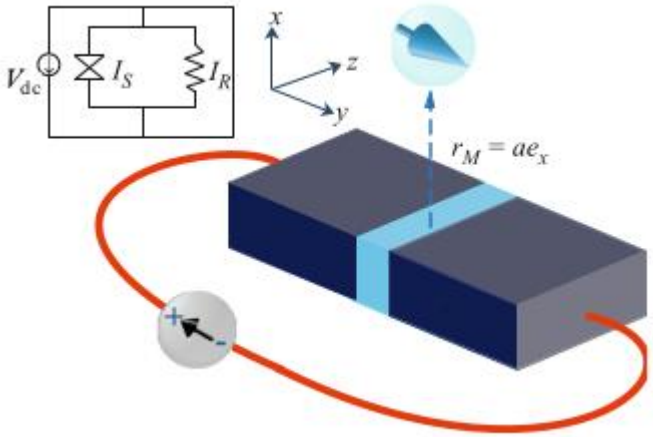
Start a task on the platform

Platform “HybriLIT”

Prototypes of information systems under development

Virtual research environment (VRE) for modeling physical processes in complex systems derived from Josephson junctions





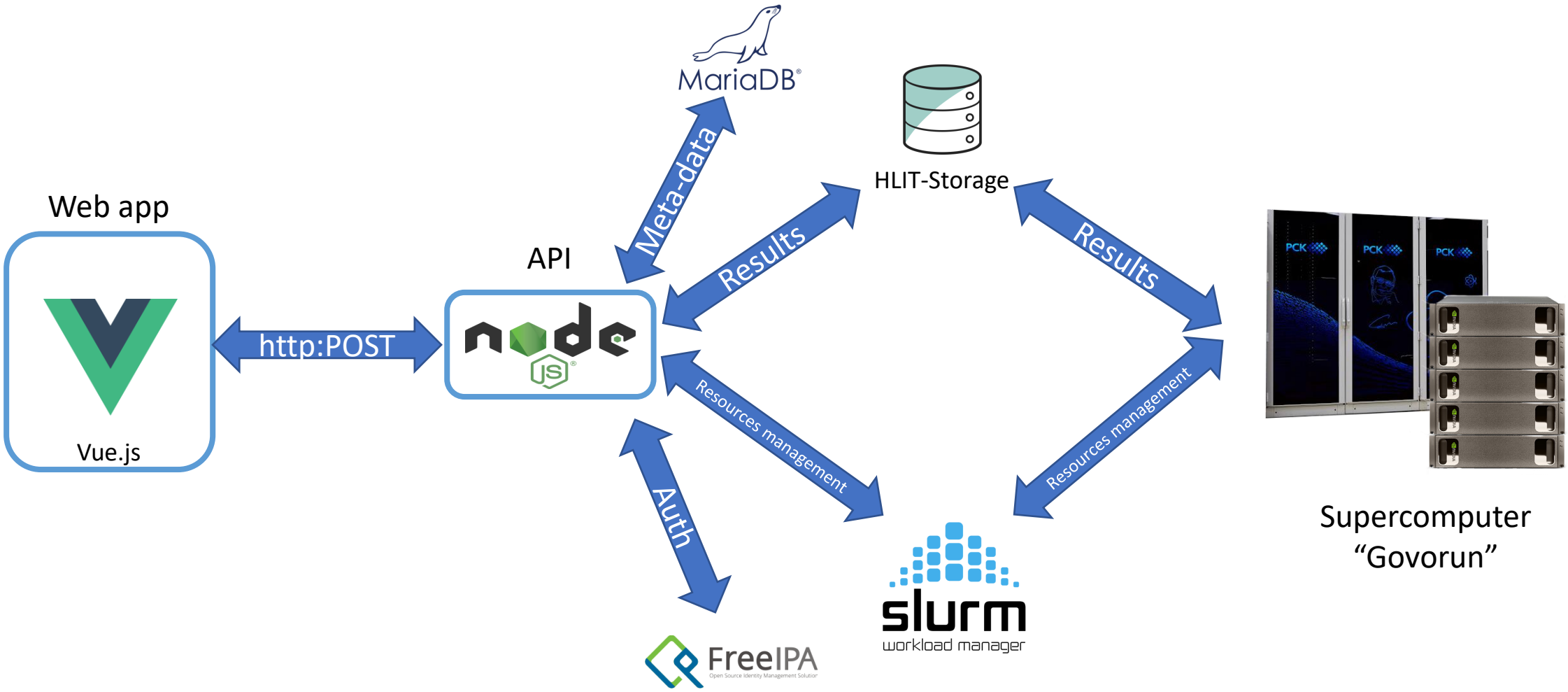
Superconducting electronics and spintronics are rapidly developing areas of condensed matter physics. Studies of Josephson junctions with magnetic systems and investigations of the possibility of changing the state of the nanomagnet array, related to the Josephson junction, using a current pulse through the junction, as well as different properties of the dynamics of such systems, occupy a significant place in these areas.

Such studies are aimed at investigating the possibility of controlling the dynamics of the magnetic moment and can help in the development of new microelectronic devices, including the implementation of quantum computing. When conducting such studies, depending on the parameters of models, distributed computing is required. It can be organized using parallel programming technologies (for example, MPI processes).

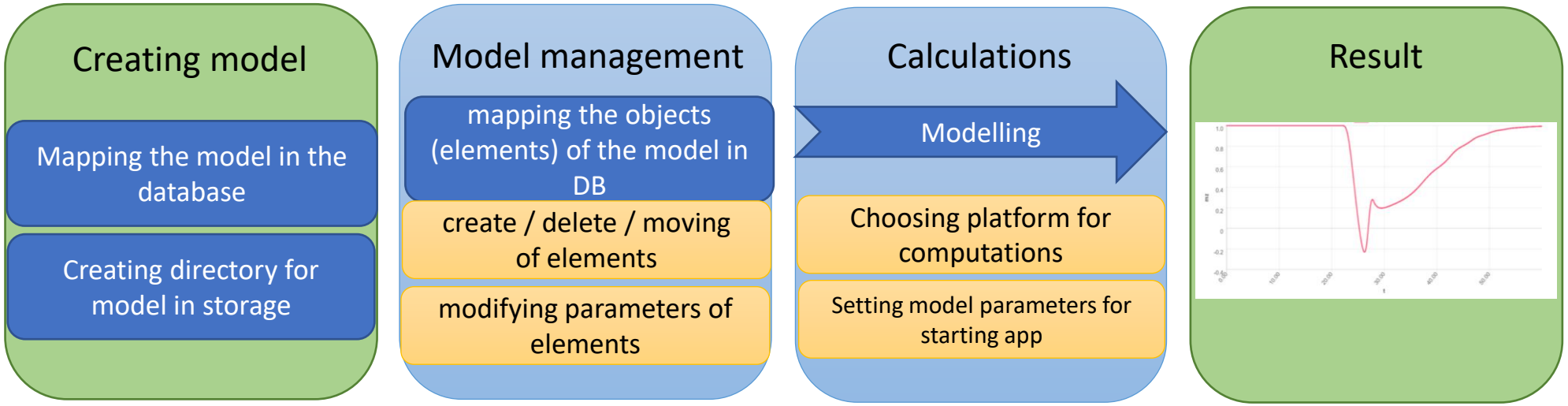
Virtual research environment (VRE) for modeling physical processes in complex systems derived from Josephson junctions

In this context, the development of a special tool based on web technologies, which would provide different research groups with an environment for organizing joint studies and exchanging models and calculation results, becomes relevant. Using the web service, users must directly interact with the resources of computing architectures, namely, launch a task with different parameters, get the status of its execution and the results of algorithms. The implementation of such functionality is possible using a client-server architecture of the web service, in which the client part provides a user interface, and the server part enables interaction with the platform.

Virtual research environment (VRE) for modeling physical processes in complex systems derived from Josephson junctions

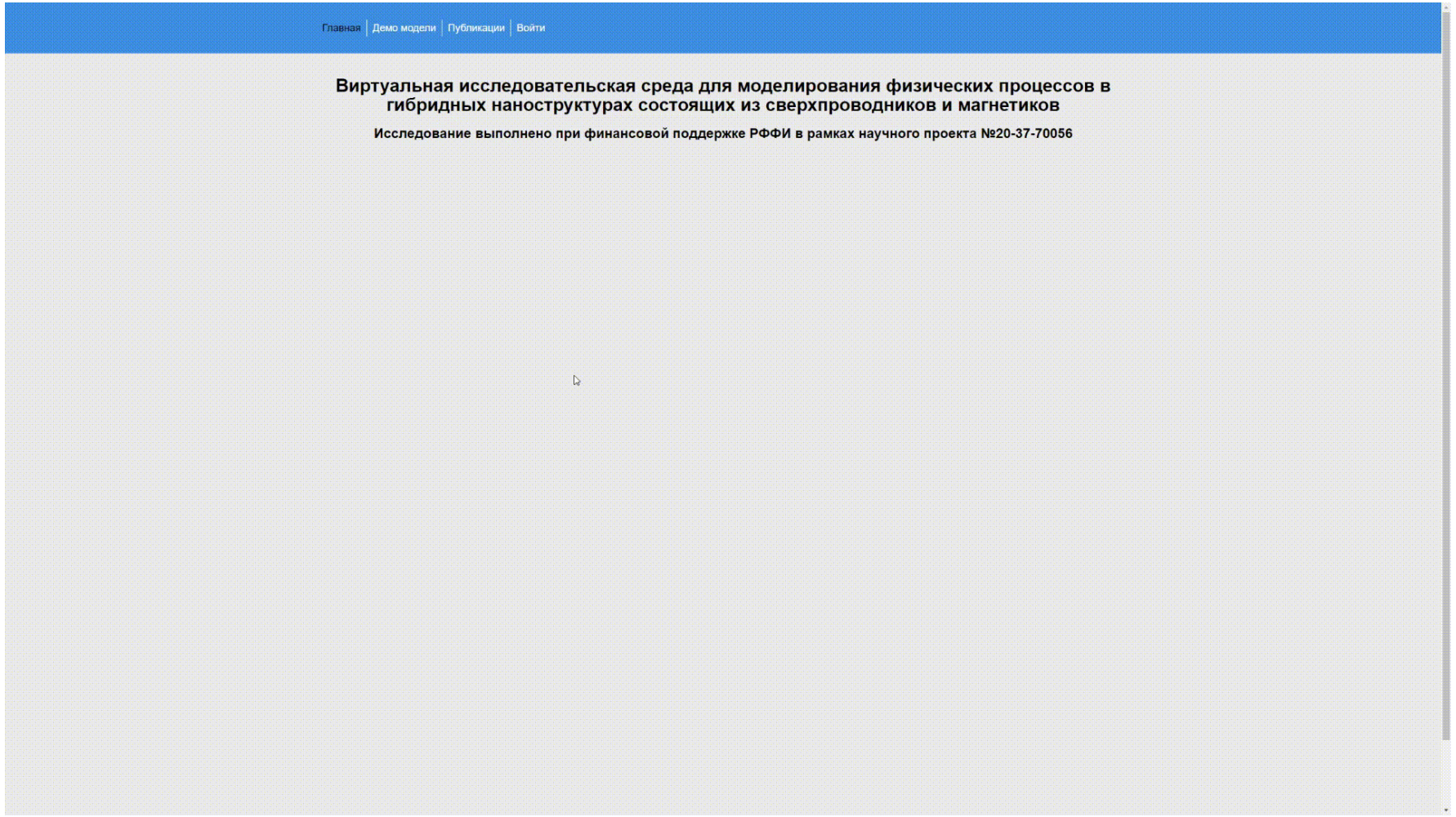


Virtual research environment (VRE) for modeling physical processes in complex systems derived from Josephson junctions



Virtual research environment (VRE) for modeling physical processes in complex systems derived from Josephson junctions

Demo



Conclusions

- To solve the tasks of mathematical modeling of physical phenomena in hybrid nanostructures comprising superconductors and magnets, a prototype of the virtual research environment (VRE) was developed.

- The developed VRE prototype allows one to create models from given elements online, to change parameters, to perform calculations on the HybriLIT platform, as well as to analyze results. The results of the study on the dynamics of the magnetic moment and the phase difference of the nanomagnet array, related to the Josephson junction, were reproduced on the basis of the VRE prototype.

- The developed approaches and IT solutions can be used to create virtual research environments for solving applied tasks in different fields of science.

- **The work was supported by the RFBR grant (No. 20-37-70056).**

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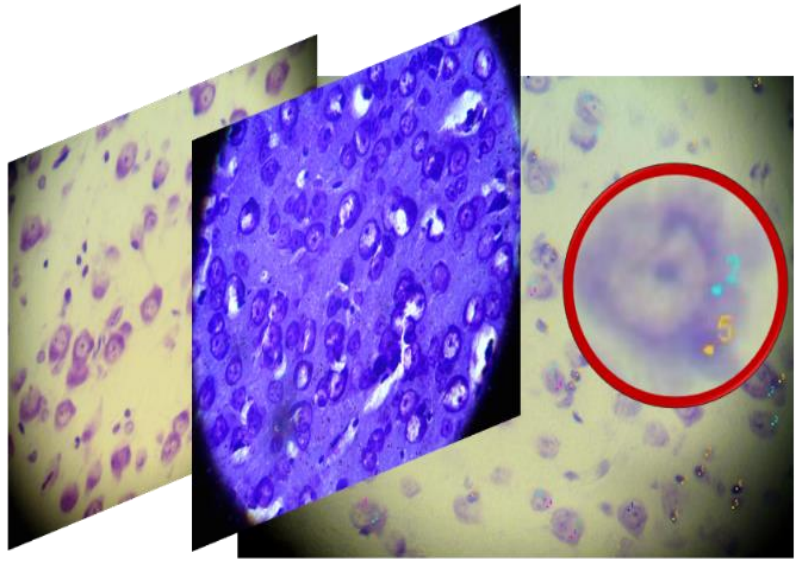
Information system for radiobiological research (Joint project of LIT and LRB)



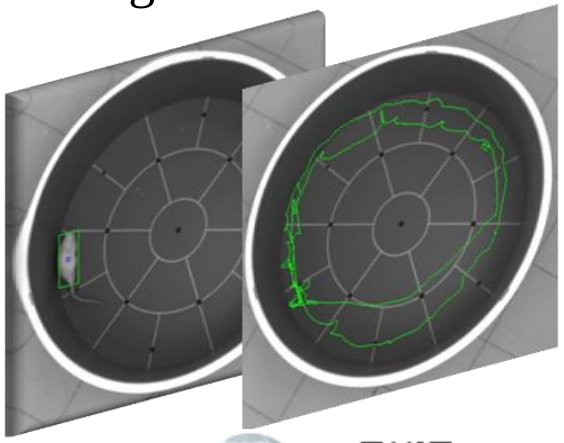
Joint project of LIT and LRB: aims at establishing an information system (IS) for analyzing behavioral and pathomorphological changes in the central nervous system when studying the effects of ionizing radiation and other factors on biological objects.

IS system is based on:

- computer vision algorithms based on machine and deep learning technologies;
- modern IT solutions for data storage, processing and visualization.

IT system will help to:

- Speed up and simplify work on experimental data for different groups of researchers
- Simplify and accelerate the diagnosis of CNS pathologies, in a particular case to use effective methods of prevention and protection from ionizing radiation.



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Information system for radiobiological research (Joint project of LIT and LRB)

1 Restricted access

Users access the service after authentication. Data is a private.

2 Work with experimental data

Storing of different data in the DB, and their modification and deletion

3 Uploading and storing files

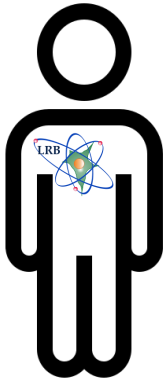
Saving photos and videos from experiments in the server file system.

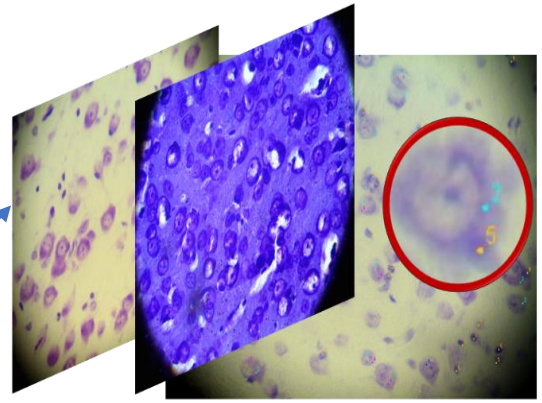
4 Presentation of results

Statistics, charts and graphs

Information system for radiobiological research (Joint project of LIT and LRB)

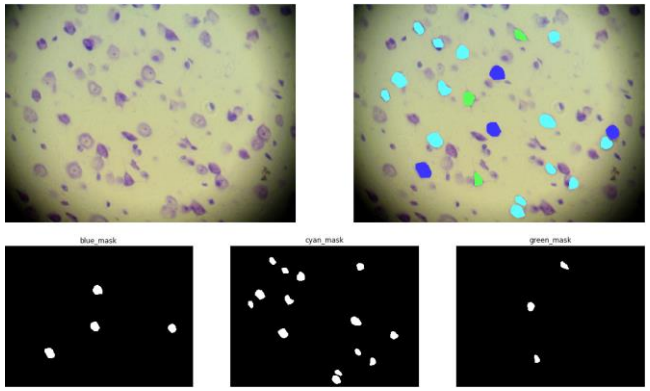
Conceptual scheme of the service



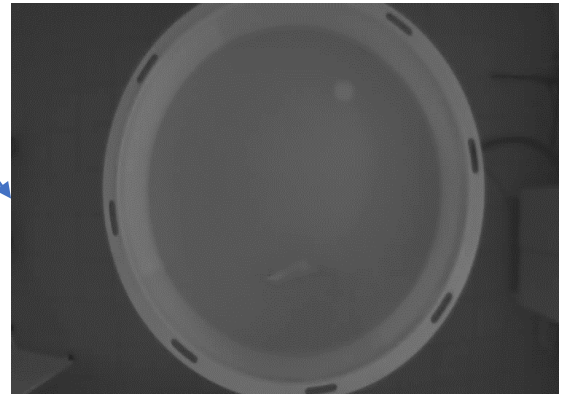


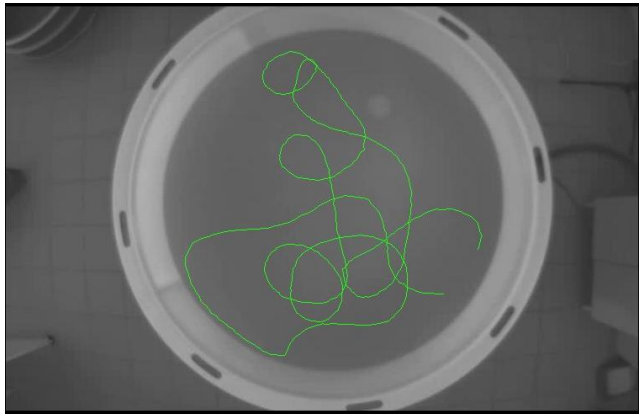
Experimental data

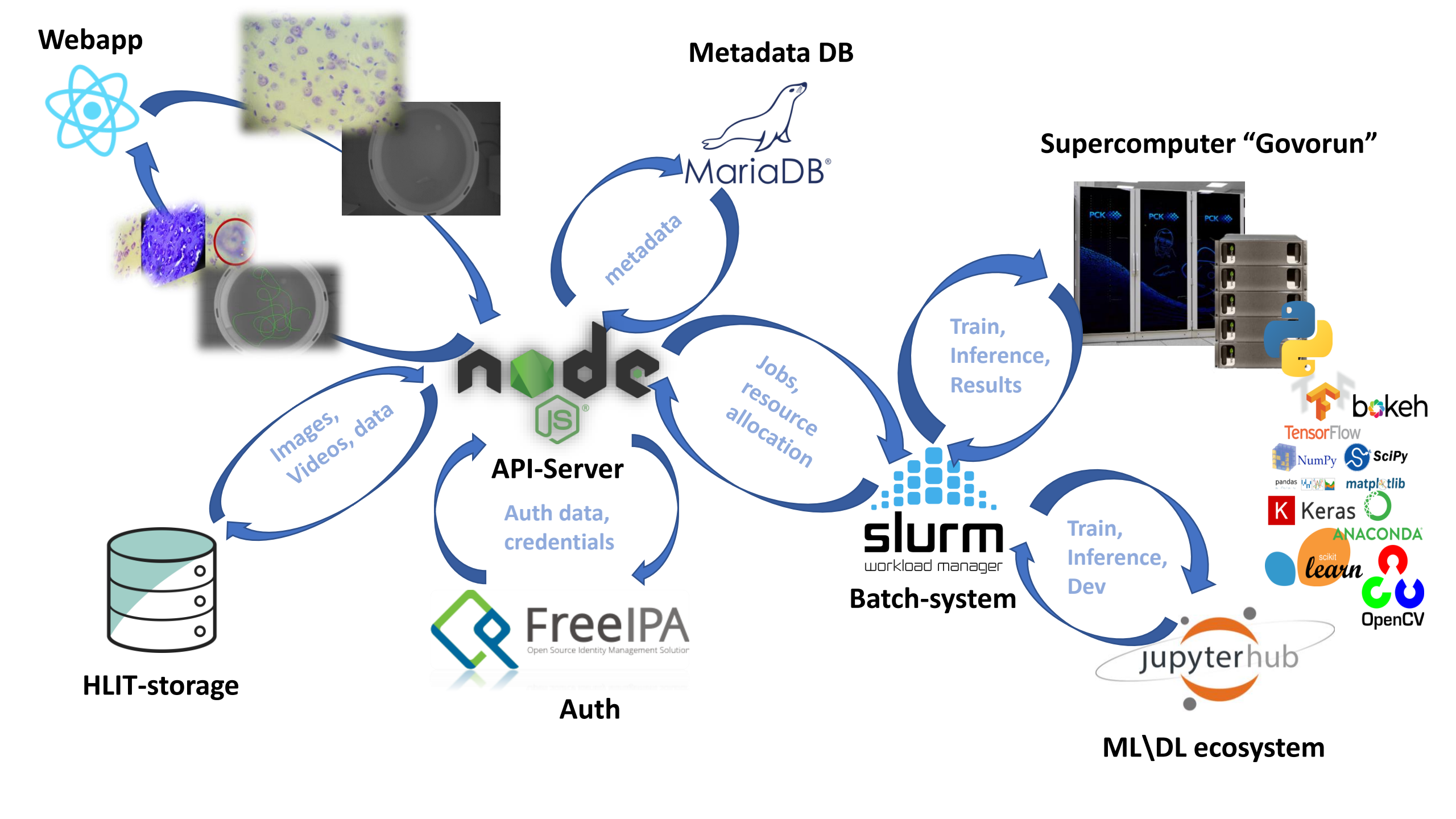
Analysis



Result

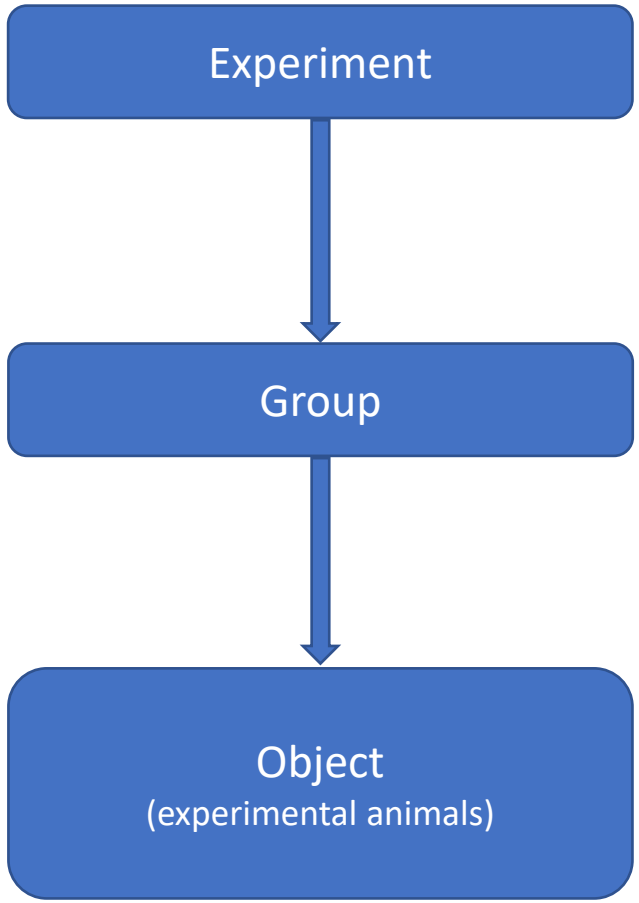





Webapp
Metadata DB
MariaDB
Supercomputer “Govorun”
metadata
Train,
Inference,
Results
Jobs,
resource
allocation
Images,
Videos, data
API-Server
Auth data,
credentials
slurm
workload manager
Batch-system
Train,
Inference,
Dev
HLIT-storage
FreeIPA
Open Source Identity Management Solution
Auth
jupyterhub
ML\DL ecosystem
bokeh
TensorFlow
NumPy
SciPy
pandas
matplotlib
Keras
ANACONDA
scikit
learn
OpenCV

Information system for radiobiological research (Joint project of LIT and LRB)

Hierarchical data structure of IS



Experiment is the major IS element inside of which all the contents of the experiment will be stored. It has a standard set of attributes: title, creator's name, creation date, description..

Group is an auxiliary IS object related to a specific experiment, inside of which data on "objects" of research (experimental animals) will be stored. In addition to the standard attributes, it has special ones: organ under study, dye, microscope magnification, drug.

Object is an auxiliary IS object related to a specific group; metadata of "objects" of the experiment will be stored inside.

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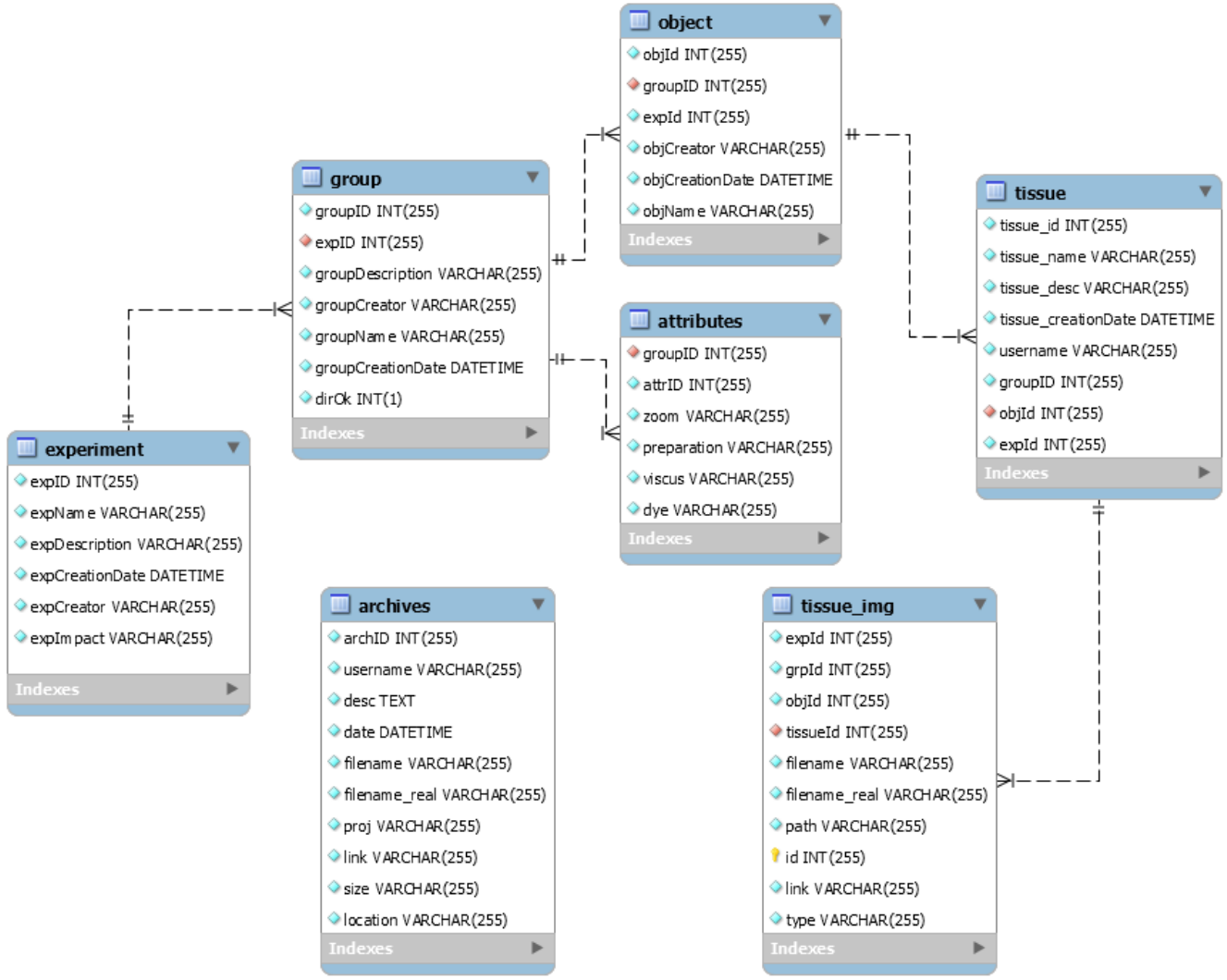
DB Scheme



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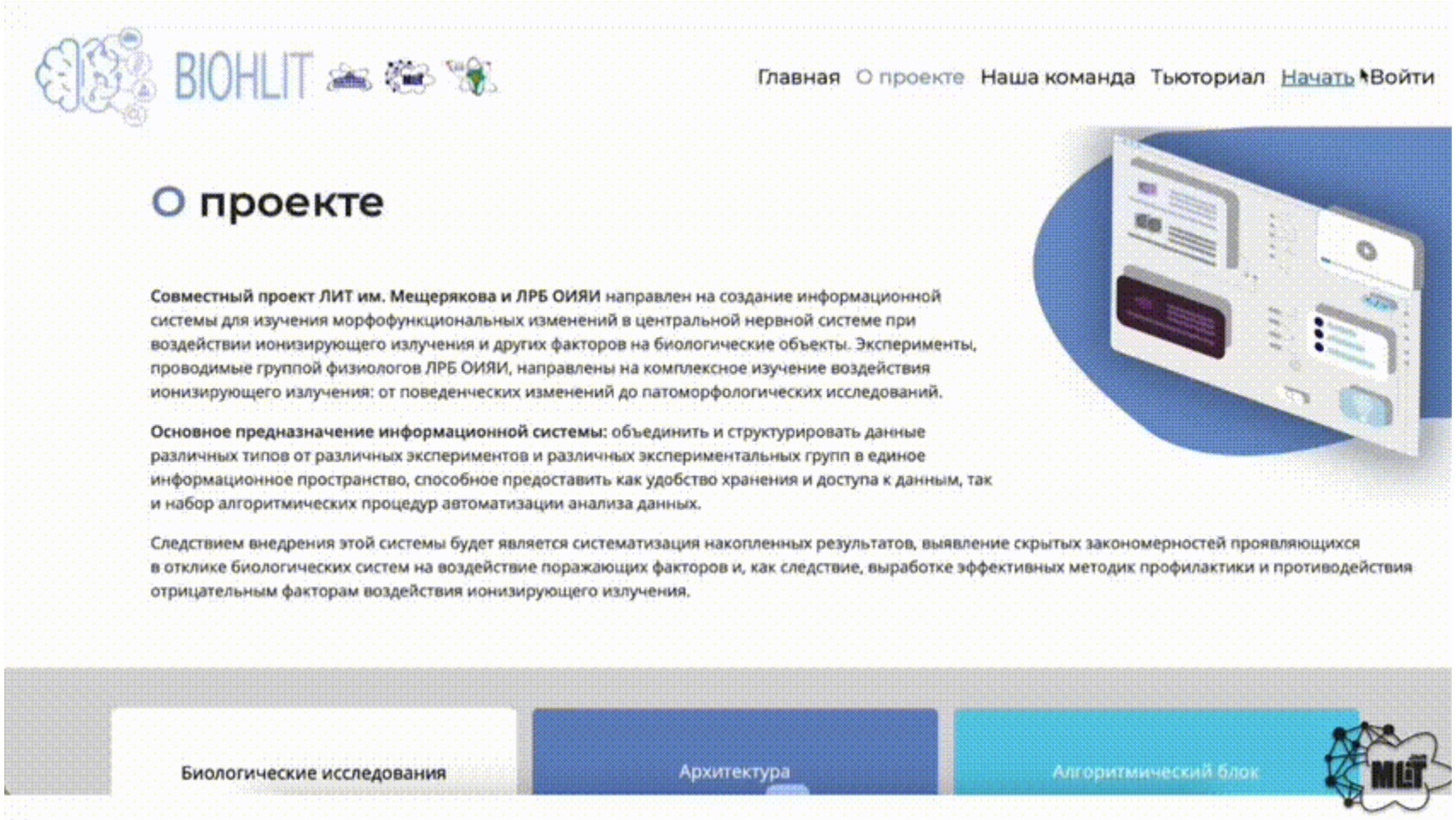
Demo



Information system for radiobiological research (Joint project of LIT and LRB)

Conclusions

Information system has been implemented as a web application and it has a client-server architecture. The server is Node.js and the client is written using the React library.

- IS takes over all necessary manipulations of the DB (database), file storage, Batch-system and other components of the HybriLIT platform;
- IS provides a convenient interface for: storing, modifying and adding experimental data;

Web applications advantages:

- No installation or update required;
- Available on all devices with the Internet (PC's, Phone's, Pad's)
- All calculations/processing will take place on a remote dedicated server.

Thanks for your attention!

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