

JOINT INSTITUTE
FOR NUCLEAR RESEARCH

THE USE OF MODERN INFORMATION TECHNOLOGIES FOR APPLIED RADIOBIOLOGICAL RESEARCH

Inna Kolesnikova

Junior researcher at the Laboratory of radiation biology, JINR

Relevance of radiobiological research



1

Use of radiotherapy



2

Space flights: the effect of ionizing radiation on the body



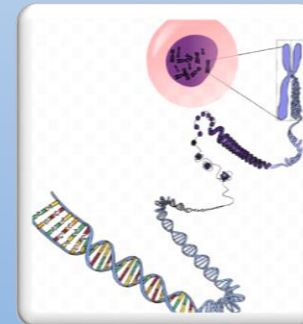
3

Protection people who work in mixed field of ionizing radiation

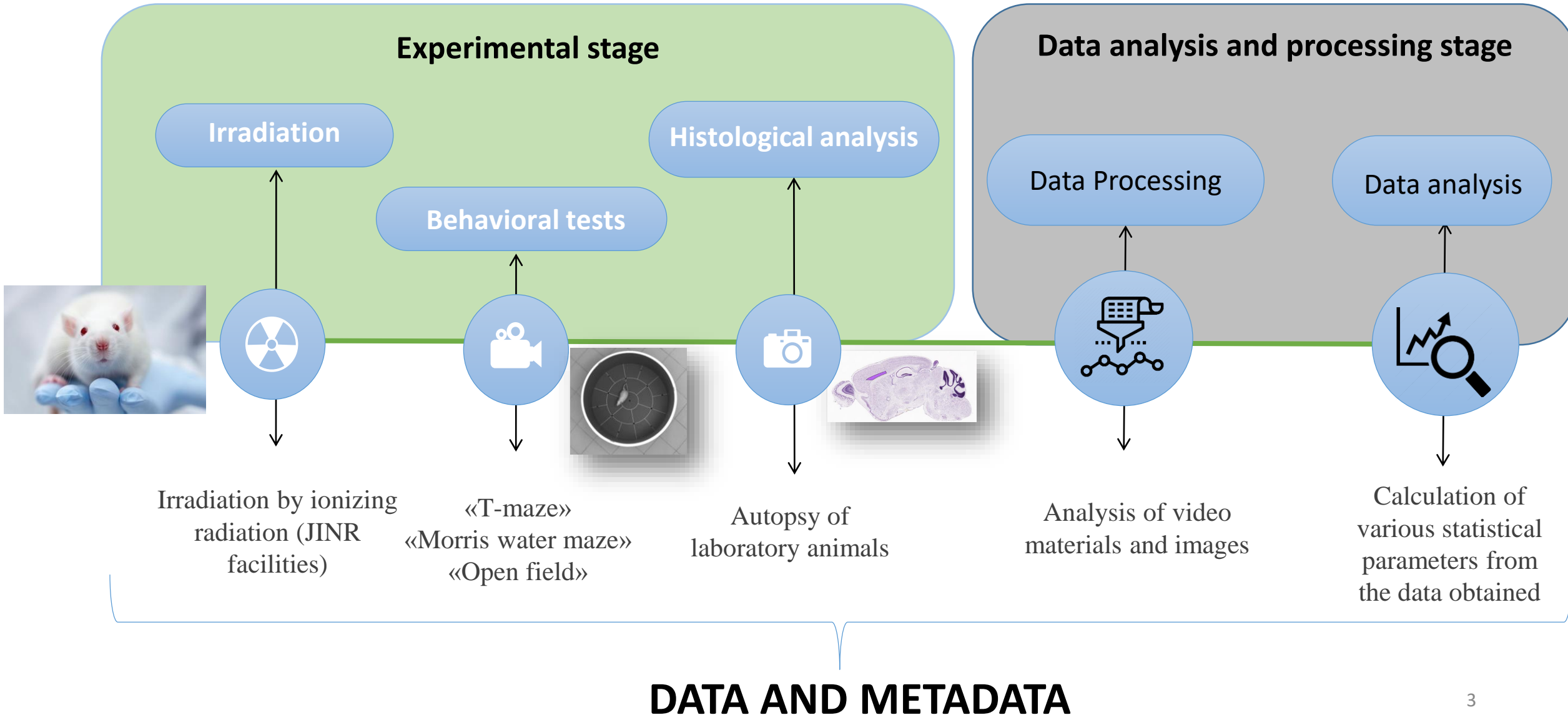
4

Study of radioprotective and radiosensitizing properties of pharmacological drugs

The main task: to assess the risk of damage after irradiation both at the cellular and organismal levels



General scheme of the experiment



Behavioral tests



Установка «Градуированный тест на тревожность» для мышей



Установка для тестов «Спонтанное распознавание новой локации объекта, «па-на-месте»»



Установка «Открытое поле», круглое



Установка «Открытое поле», квадратное



Установка «Приподнятый крестообразный лабиринт»



Установка «Экстраполяционное избавление»



Установка «Т-лабиринт»



Установка «Инвертированный Т-лабиринт»



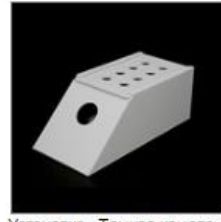
Установка «Темно-светлая камера»



Установка для тестов «Поведение отчаяния» по Porolt и «Вынужденное плавание»



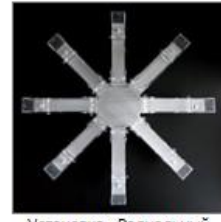
Установка «Beam walking (сужающаяся дорожка)»



Установка «Темная камера с отверстиями»



Установка «Staircase test (сужающаяся дорожка)»



Установка «Радиальный восьмирукавный лабиринт»



Закрытый крестообразный лабиринт



Установка «О-лабиринт»



Установка «Водный лабиринт (тест Морриса)»



Установка «Лабиринт Барнса»



Установка «Тест цилиндр»



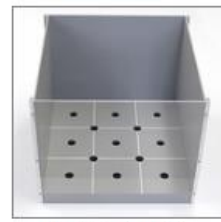
Установка «Y-лабиринт»



Установка для оценки вертикализации у мышей



Установка «Тест предпочтения места»



Норковая камера



Установка для оценки катаlepsии



Установка «Трёхкамерный социальный тест»



Установка для исследования социального поведения



Тест на переключаемость внимания



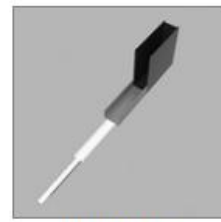
Тест подвешивания за хвост



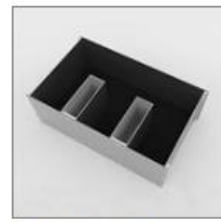
Многофункциональная установка для водного теста «Экстраполяционное избавление»



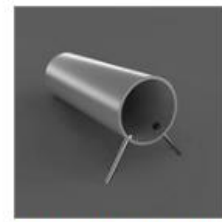
Установка «Rung ladder (лестница с перекладинами)»



Установка «Тест последовательных лучей»



Установка «Е-лабиринт»



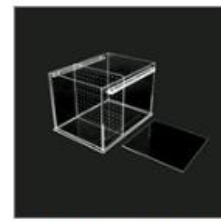
Цилиндр для оценки норного поведения



Тест доминирования

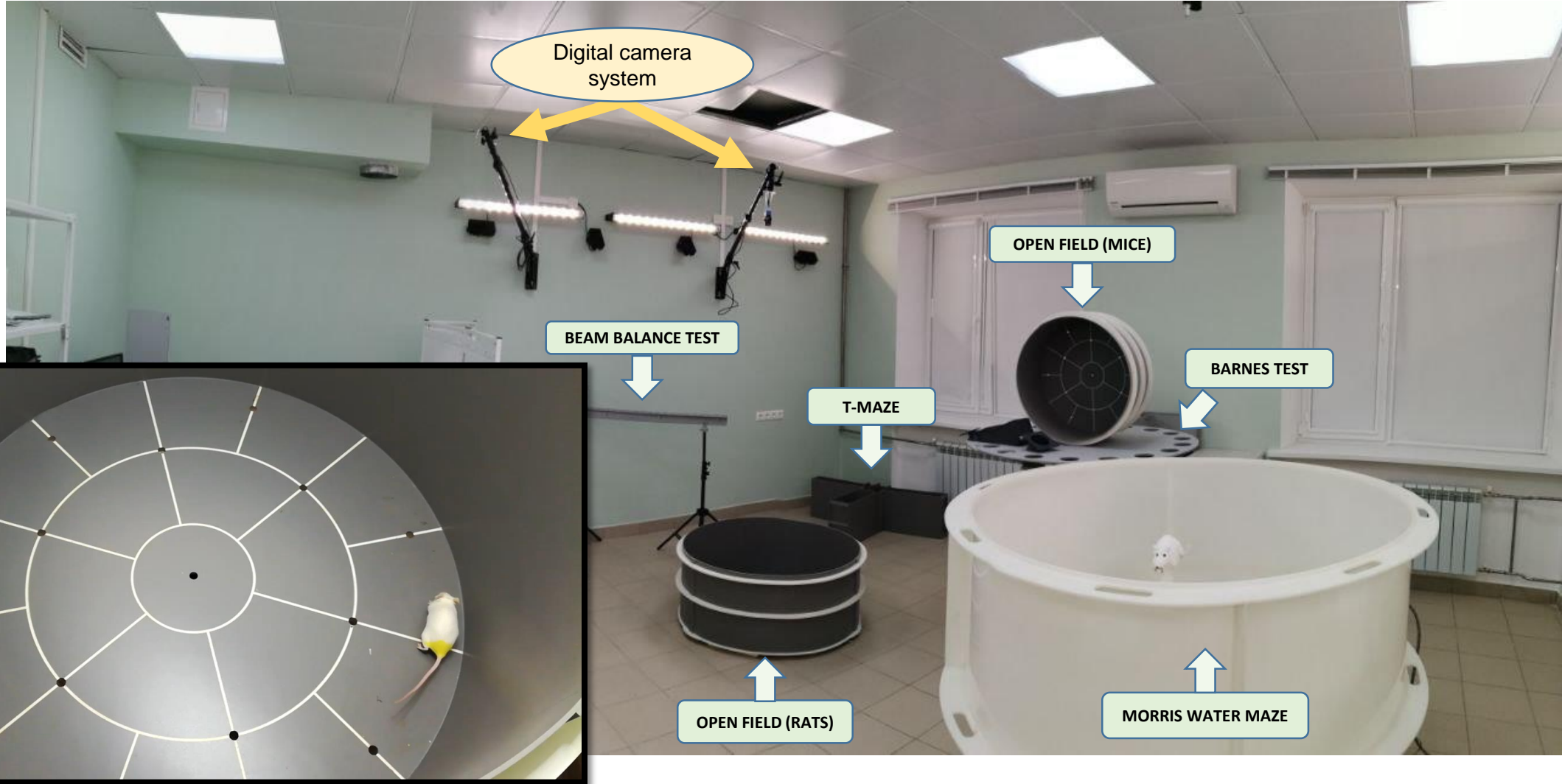


Открытое поле для Dario








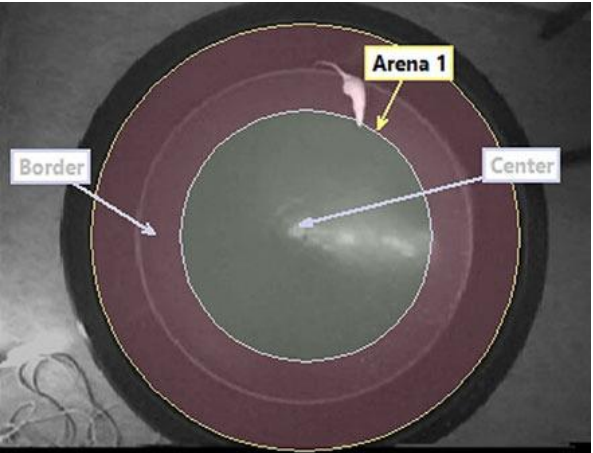
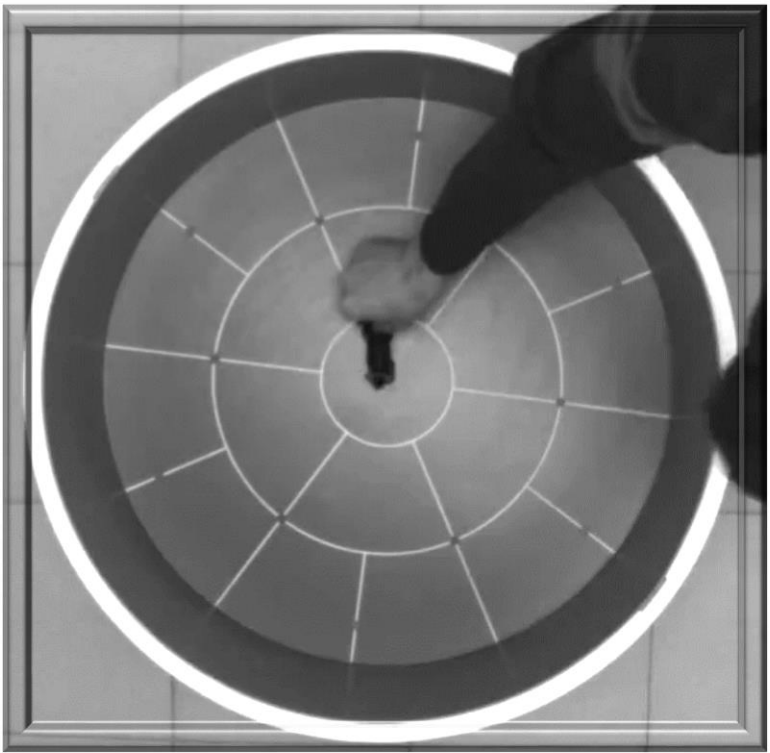
Установка для исследования социального поведения Dario

Behavioral laboratory room



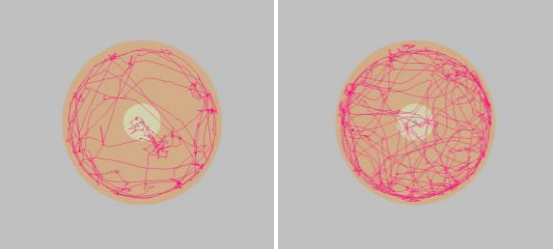
Behavioral analysis

3 min	<i>Grooming</i>	<i>Sectors crossings</i>	<i>Center entrance</i>	<i>Stand ups</i>	<i>Hole dipping</i>	<i>Freezing</i>
<u>Control</u>	8		7		5	
<u>Irradiated</u>	5	4	6	3	4	0
6 min						
<u>control</u>	5	1	4			1
<u>Irradiated</u>	2	5	4	9	7	1

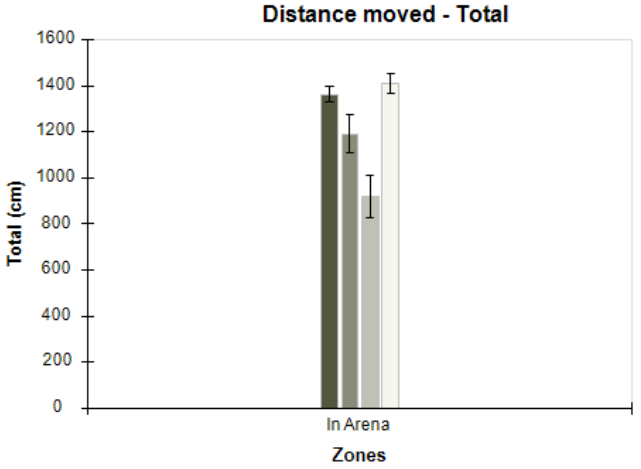
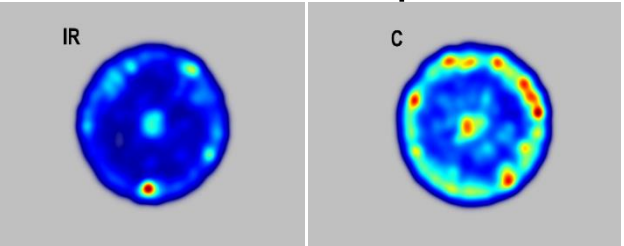


Open Field

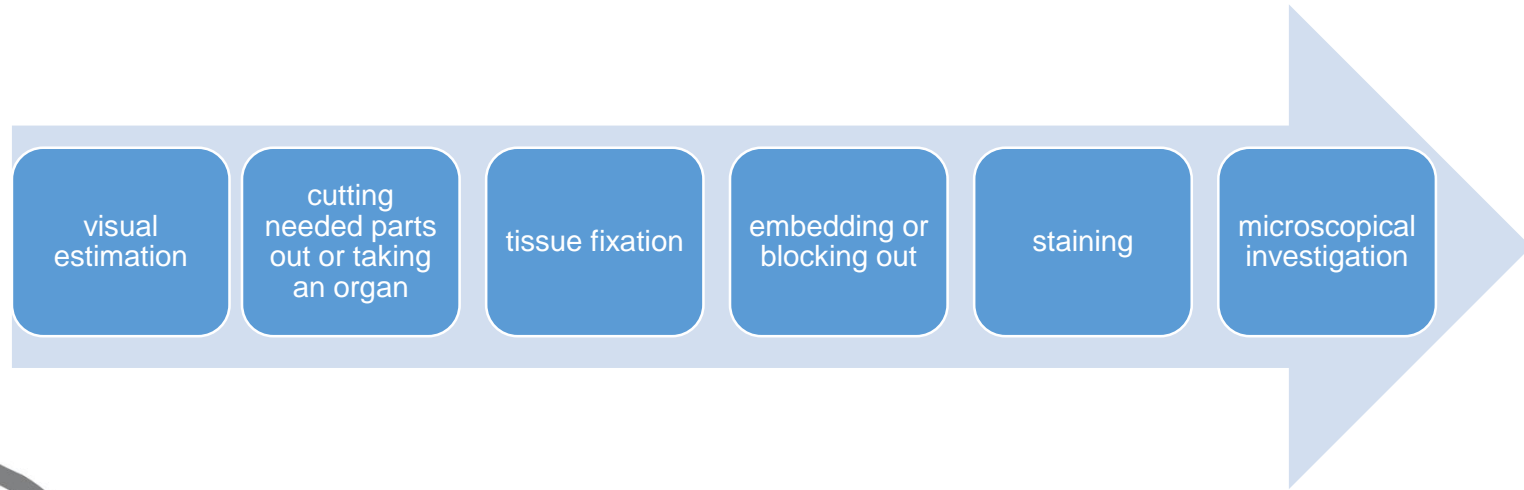
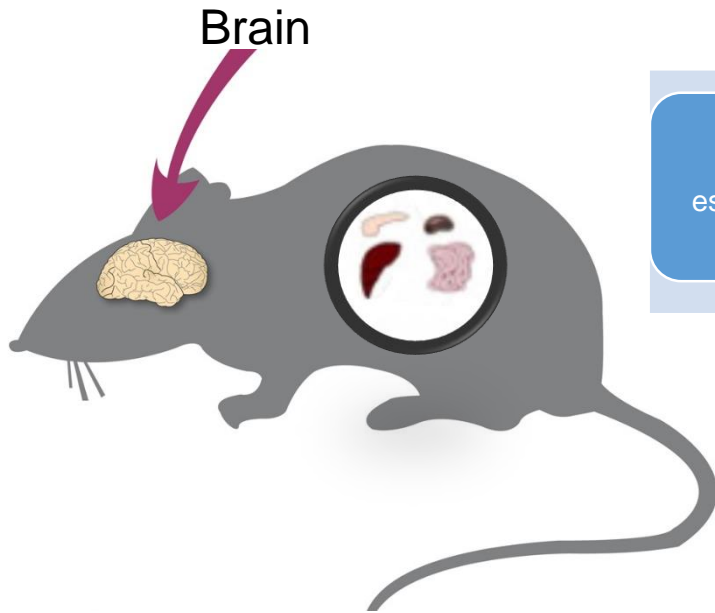
Tracking



Heatmap





Autopsy of laboratory rodents



thymus, spleen, brain

liver, small intestine, kidney, brain



A box containing two rounded rectangular text boxes. The top one says "thymus, spleen, brain" and the bottom one says "liver, small intestine, kidney, brain". To the right of the top box is a black icon of a balance scale. To the right of the bottom box is a black icon of a microscope.



blood

A composite image showing a Mindray BC-2800 Vet blood analyzer, a gloved hand holding a test tube with red liquid, and several petri dishes with a white mouse. Below the images is a rounded rectangular box with the word "blood".

Histological methods



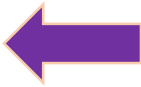
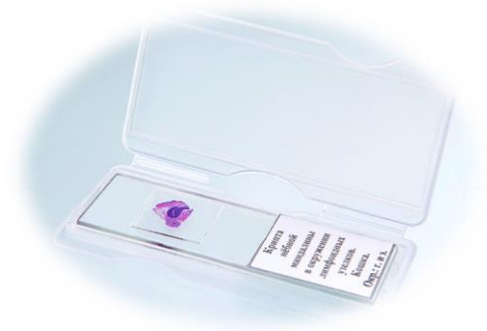
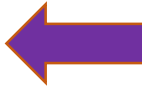
Paraffin block



Histological slides



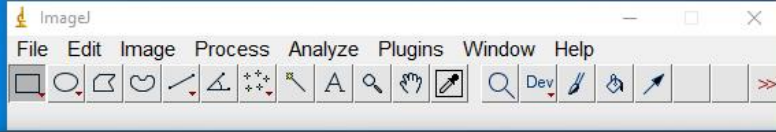
Staining



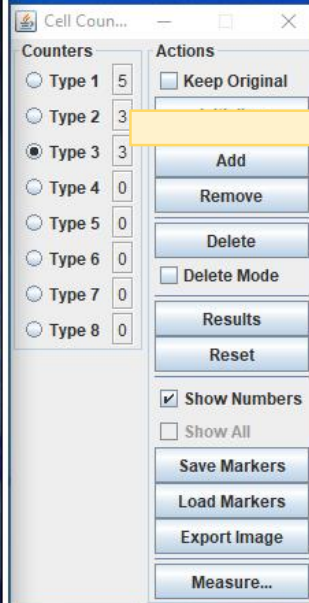
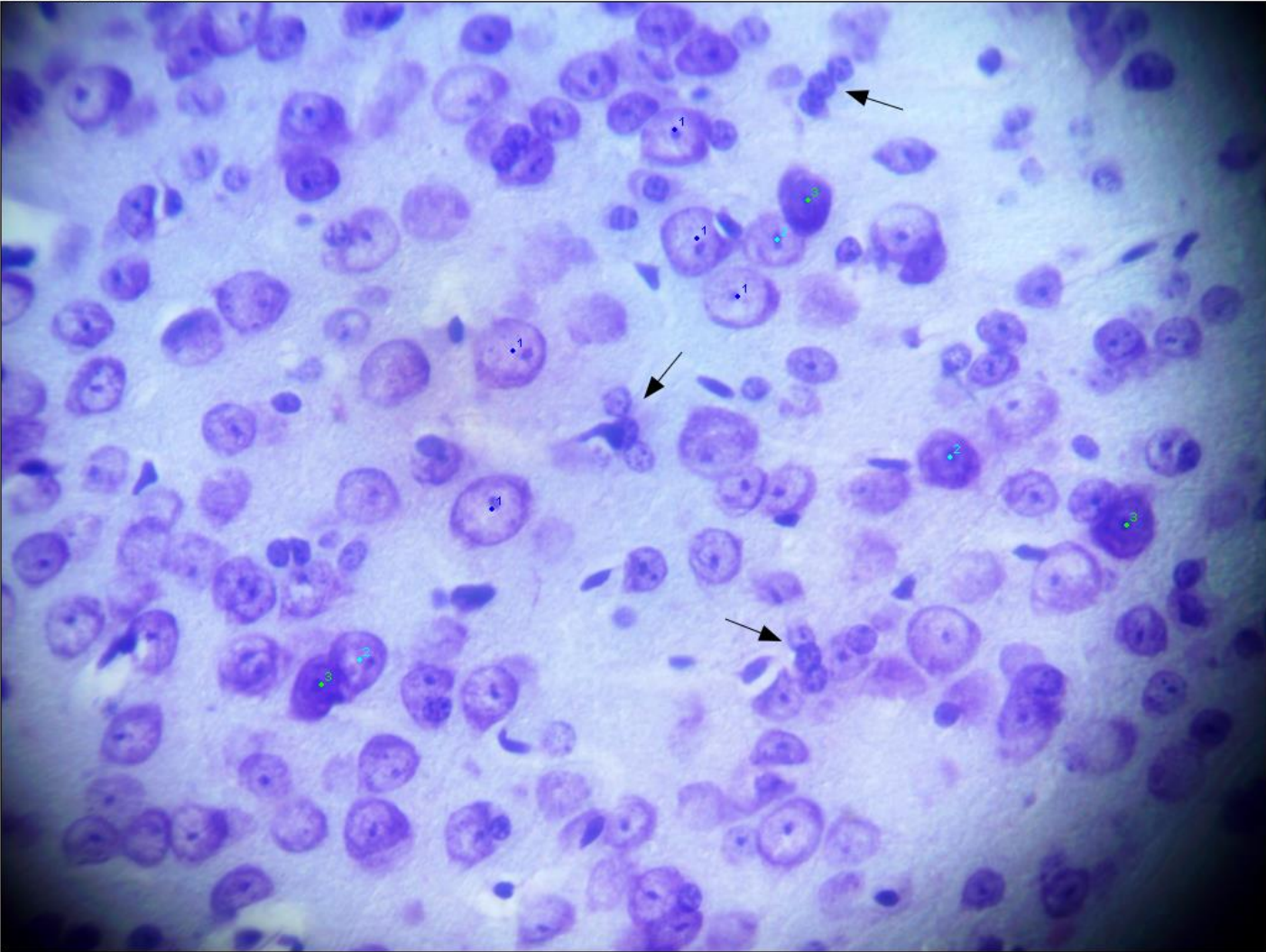
- [congo red](#)
- [cresyl violet \(Nissl\)](#)
- [hematoxylin eosin](#)
- [fluoro-Jade B](#)

Tools for histological analysis

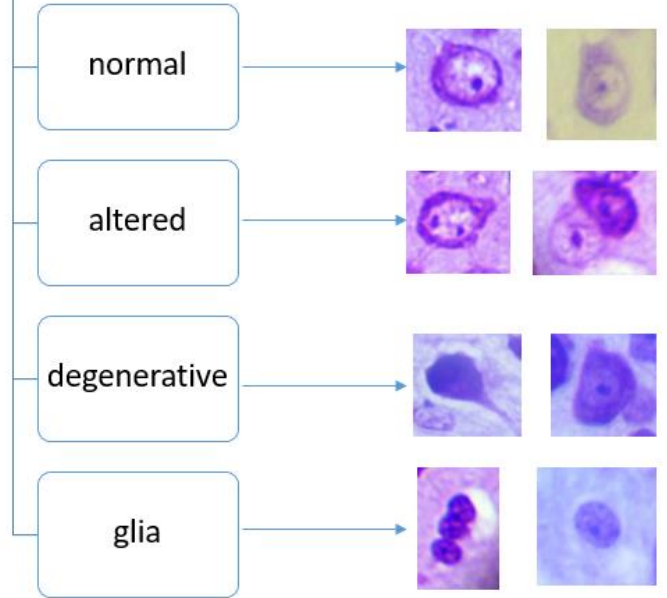
ImageJ



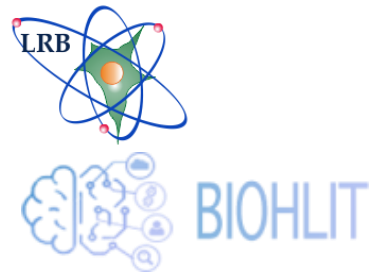
Counter Window - gamma_9-1_II-847 - гиперплазия глии.png (50%)
2048x1536 pixels; RGB; 12MB



Classification of brain cells:



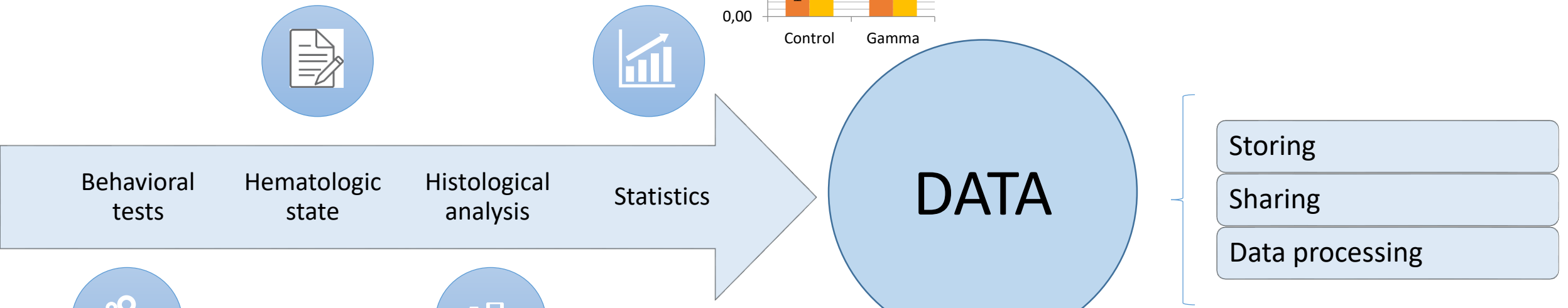
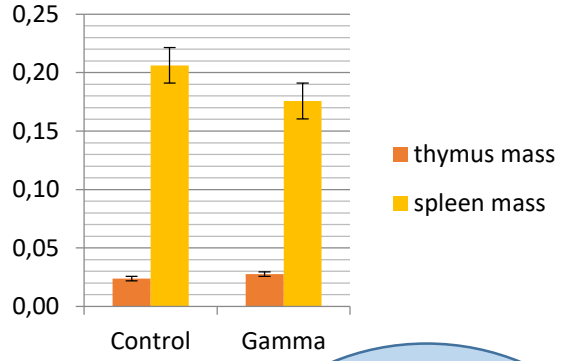
Comprehensive analysis of the results obtained at all stages of the study



Tables

№	body weight	brain mass	thymus mass	spleen mass	leukocyte
1	41	0,54	0,040	0,370	3,80
2	44	0,55	0,015	0,190	3,60
3	45	0,54	0,024	0,155	3,00
4	43	0,57	0,035	0,156	3,90
5	46	0,52	0,018	0,138	3,40
6	46	0,54	0,019	0,247	3,20

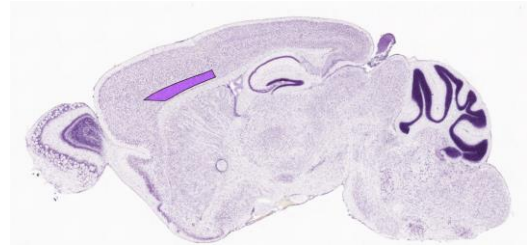
Graphs



Video materials



Photos



.pdf/.doc of protocols, .opju of statistics, etc

Our projects



BIOHLIT



The Computer-Assisted Identification, Characterization, and Modeling of the Histological Data

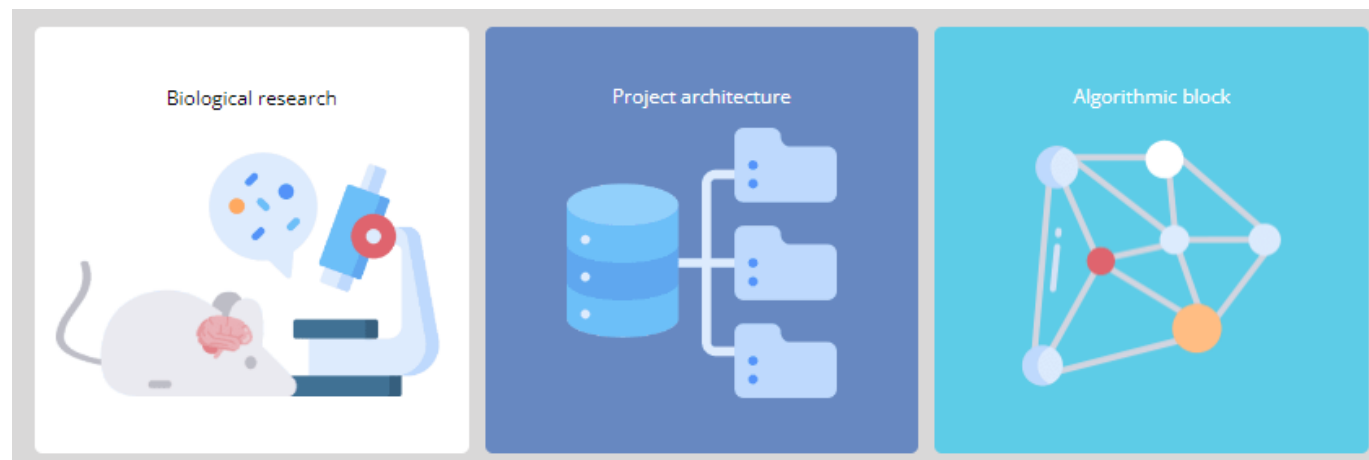
A project within the Cooperation Agreement between the Joint Institute for Nuclear Research (JINR), Dubna, Russian Federation, and the Ministry of Education and Science of the Republic of Serbia.

Tasks:

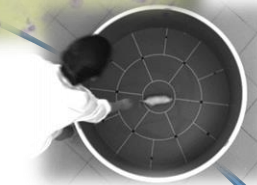
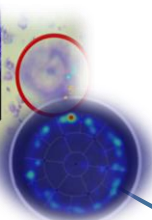
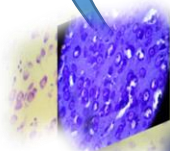
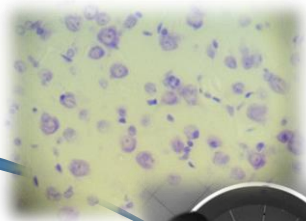
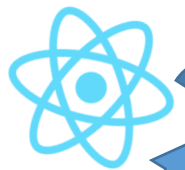
- Information system for analyzing our data, solving, protection and giving an opportunity to have an access to the data online
- Developing the algorithms for behavioral patterns recognition in the mazes
- Developing algorithms for histological analysis of brain tissue
- Statistical analysis

Tasks:

- Atomize segmentation, identification, and characterization of the brain cells
- Recognition degenerative neurons
- Improving the quality of histological pics the effect of blinds (if the last one is not crucial)



Webapp



Metadata DB



MariaDB®

Supercomputer "Govorun"



bokke

TensorFlow



NumPy

SciPy

pandas

matplotlib

Keras

ANACONDA

scikit-learn

learn

MATLAB

OpenCV

Train, Inference, Dev

jupyterhub

ML\DL ecosystem

node JS

API-Server

Auth data, credentials

FreeIPA Open Source Identity Management Solution

Auth

metadata

Jobs, resource allocation

Train, Inference, Results

slurm workload manager

Batch-system

HLIT-storage, JINR EOS



Images, Videos, data



ML/DL and data analysis ecosystem + JLabHPC



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



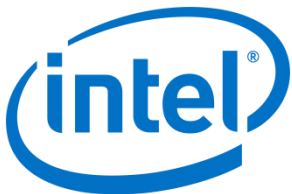
8x GPU Volta V100 is available for learning of convolutional neural networks



Popular frameworks and software for DL/ML/CV/Data Processing (Tensorflow, Keras, Pytorch, OpenCV, Matlab, etc.) are assembled and ready for use.



Large specter of available Python libraries for data analysis and visualization



more ...



<http://hlit.jinr.ru/>

HPClab component

VM with JupyterHub and SLURM [<https://jlabhpc.jinr.ru>]

- ❑ Intel Xeon Gold 6126 (24 Cores @ 2.6 GHz)
- ❑ 32 GB RAM

Educational component

JupyterLab Server [<https://studhub.jinr.ru>]

[<https://studhub2.jinr.ru>]

- ❑ 2x Intel Xeon Gold 6152 (22 Cores @ 2.1 GHz)
- ❑ 512 GB RAM

Computation component

Server with NVIDIA Volta [<https://jhub1.jinr.ru>]

[<https://jhub2.jinr.ru>]

- ❑ 2x Intel Xeon Gold 6148 (20 Cores @ 2.4 GHz)
- ❑ 4x NVIDIA Tesla V100 SXM2 32 GB HBM2
- ❑ 512 GB RAM

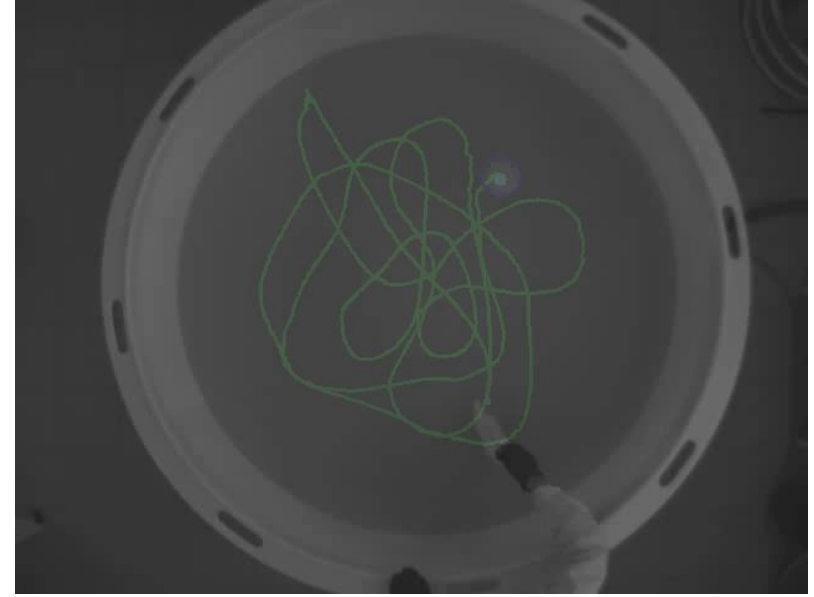
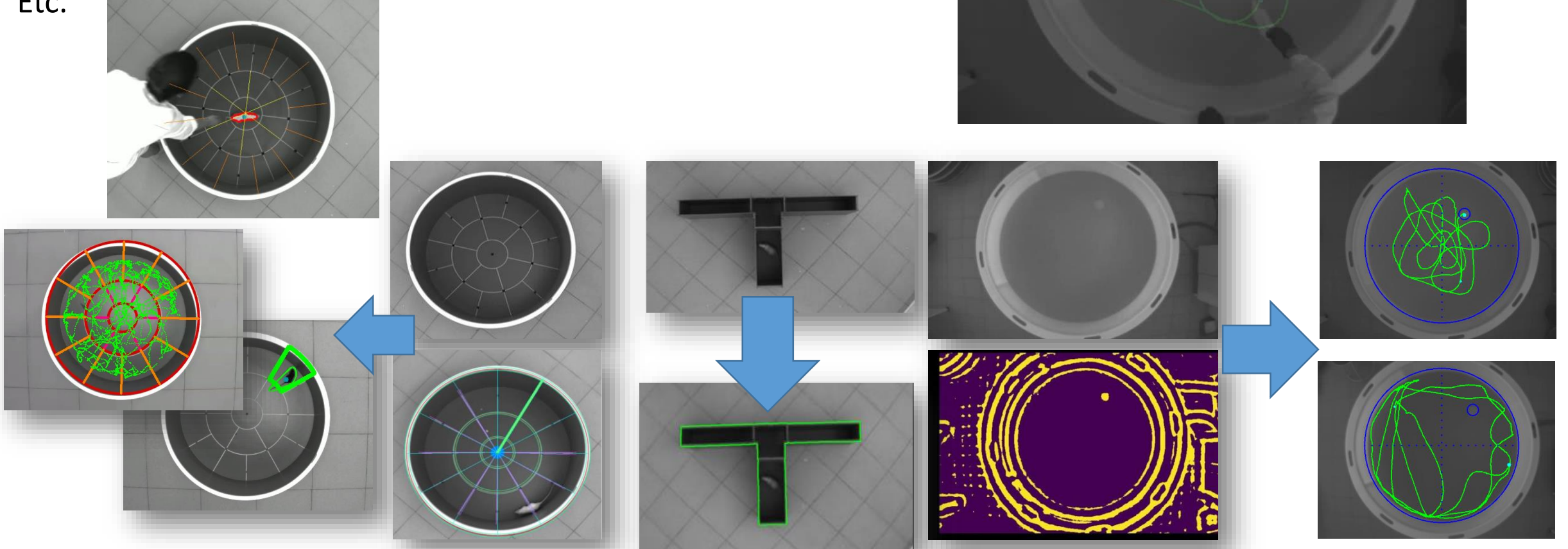
[<https://jhub3.jinr.ru>]

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

Tasks of the algorithmic block of the Information System

Behavioral part:

- Analysis of the experimental field markup
- Tracking the position of the animal as part of the experiment
- Classification and determination of the type of animal activity
- Etc.

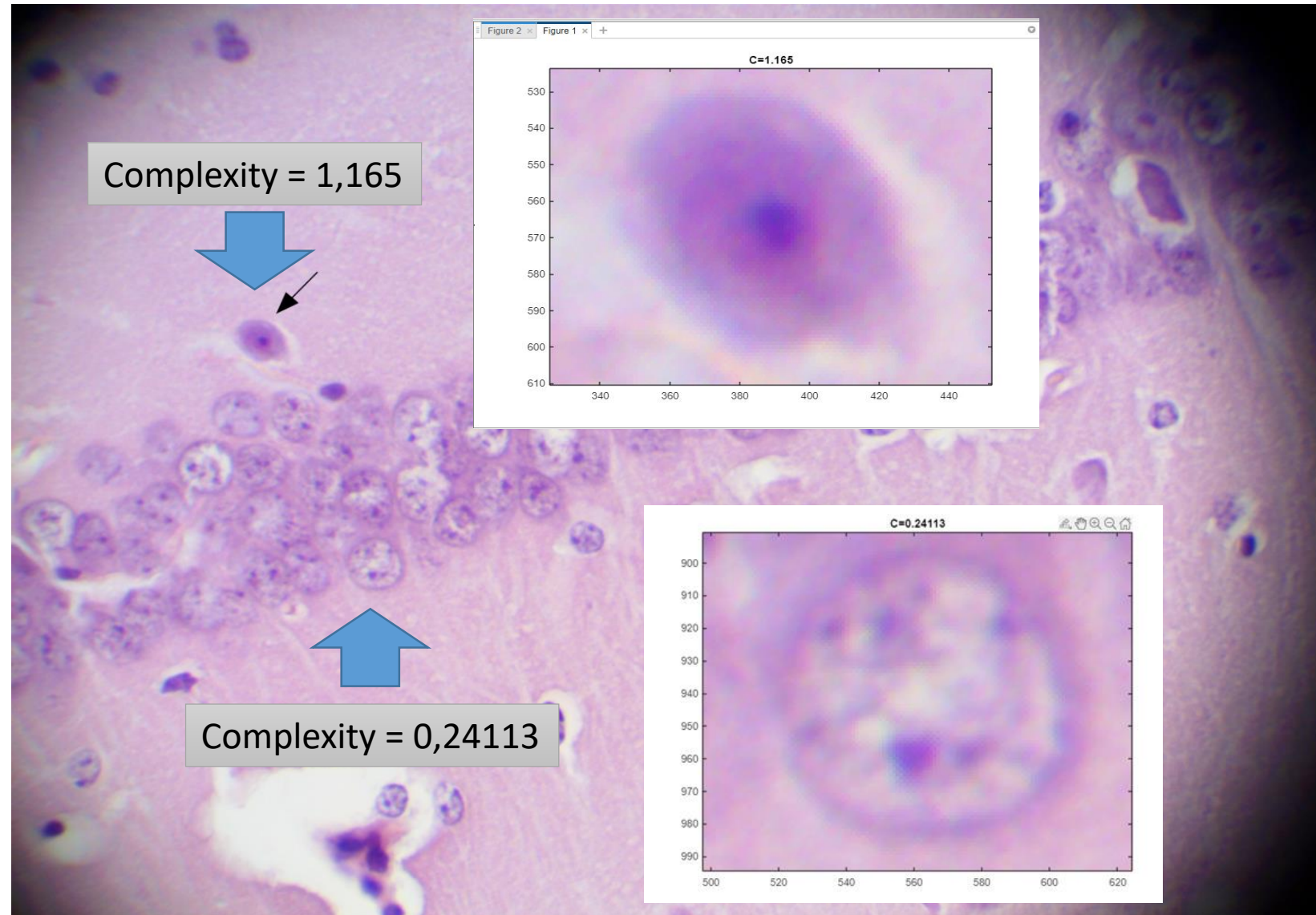




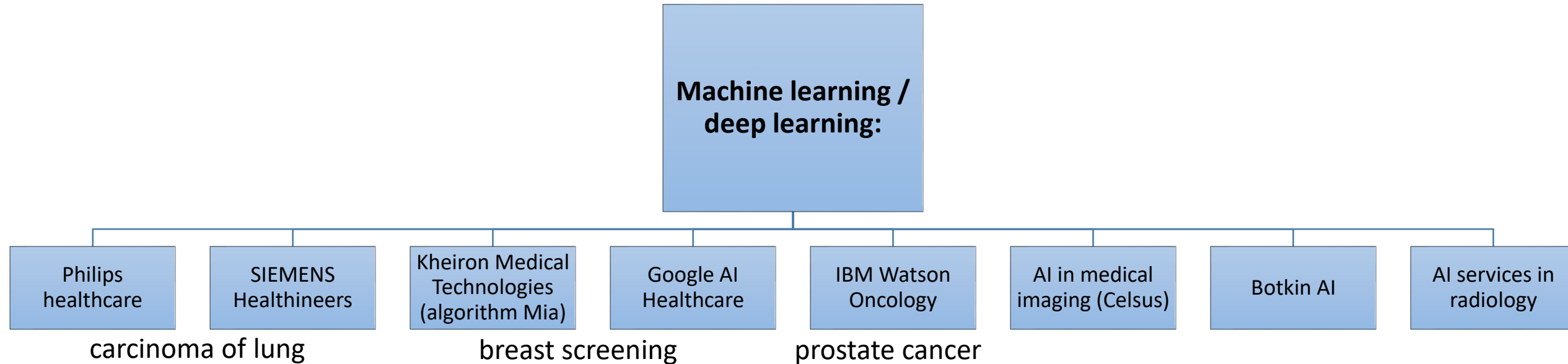
Institute of Nuclear Sciences Vinca

- Mathlab
 - Code
- Dataset of hippocampus cells
 - Classification: dark and light cells

As a result we get structural complexity

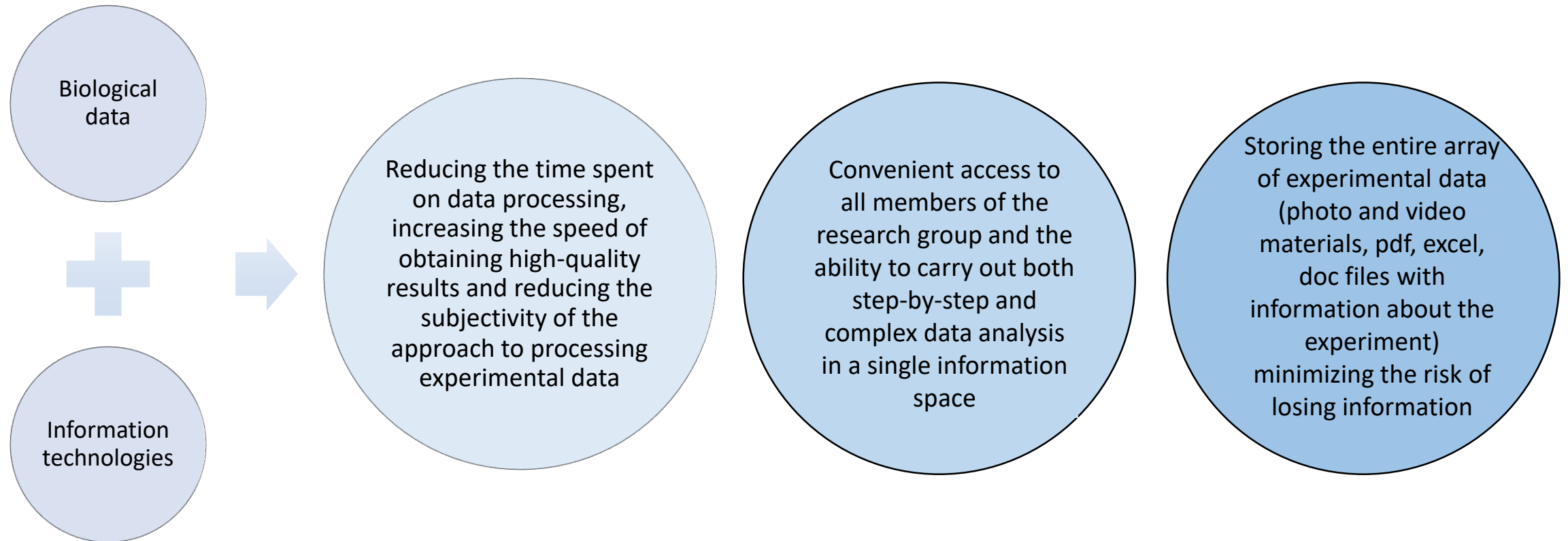


IT for biological endeavors



- Now the accuracy is >93% (mammography, fluography)
- The use of ML systems accelerates the description of mammographic examination by 30-40%.
- ML provides a significant (by 15-25%) increase in the accuracy of predicting cancer predisposition, relapses and mortality.
- According to the results of AI testing to detect breast cancer, the time to describe the study is reduced by 15-50%.
- DL can not only accurately distinguish between the two most common subtypes of lung cancer, adenocarcinoma and squamous cell carcinoma but also predict mutated genes from images.
- etc.

***Digital pathology**



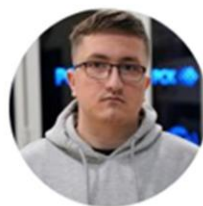
Artificial intelligence cannot replace specialists. But it can become an excellent tool for data mining.



Dr Oksana Streltsova



Tatevik Bezhanyan



Yuri Butenko



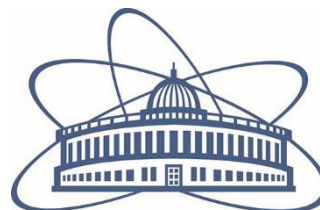
Andrey Nechaevskiy



Maxim Zuev



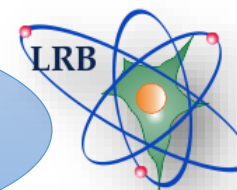
Anastasia Anikina



JOINT INSTITUTE
FOR NUCLEAR RESEARCH



OUR TEAM



Dr Marko Ćosić

Head from Serbia

Laboratory of Physics, Vinča
Institute of Nuclear Sciences –
National Institute of the Republic
of Serbia



Dr Sanja Despotović

Institute for Histology and
Embryology "Aleksandar Đ. Kostić",
Faculty of Medicine



Milivoje Hadžijojić

Laboratory of Physics, Vinča
Institute of Nuclear Sciences –
National Institute of the Republic
of Serbia



Katarina Erić

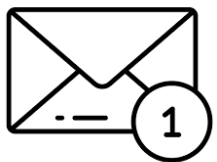
University Clinical Centre of Serbia,
Department of Histopathology



**The Computer-Assisted Identification, Characterization,
and Modeling of the Histological Data**

A project within the Cooperation Agreement between the Joint Institute for Nuclear Research (JINR), Dubna, Russian Federation, and the Ministry of Education and Science of the Republic of Serbia.

Thanks for your attention!



innakolesnikova@jinr.ru

