



The diagram shows a series of lines representing particle tracks. A primary track enters from the top left and splits into multiple secondary tracks, which then further branch into tertiary tracks, illustrating a particle cascade or shower. Some tracks are labeled with 'L' and 'H'.

# **“SHOWERS OF KNOWLEDGE”**

## **The open-source educational project**

Victoria Tokareva (JINR)  
Workshop high school cosmic ray experiments

Rome, 15 February 2017

# Structure of the project

Showers of Knowledge (Livni znaniy) project consists of:

- ▶ distributed facility RUSALKA (“mermaid”);
- ▶ unique interactive internet portal <http://livni.jinr.ru>.

The screenshot shows the web interface of the 'Showers of Knowledge' project. At the top is a navigation bar with links: Shower of knowledge, News, Project, Setup, Tasks, Research, Manual, About site, and Contacts. On the left is a sidebar with a user greeting 'Hi - -, Log out', language selection flags (Russian, English, etc.), a search bar, and links for Running tasks, Weather Station, Old 'Livni' page, References, and elkinlab\_en. The main content area features an aerial photograph of the RUSALKA facility with 11 numbered markers (1-11) in red and green circles. Below the photo is a welcome message: 'Welcome, dear Guest! We are glad to see you in our laboratory of cosmic rays. We suggest you to start from surfing through the available sections and try to make the simplest analysis of real experimental data, which our station provides continuously. We hope that it will entice you and you will become a permanent and full-fledged member of our international laboratory.' This is followed by a section titled 'Data accumulation in real time' with the text 'Status of the stations on JINR setup (see statistics). Click on the station number to watch it's current statictics.' At the bottom is a horizontal bar showing the status of 11 stations, each with a number and a colored dot (green for active, red for inactive).

Station	1	2	3	4	5	6	7	8	9	10	11
Status	Green	Green	Red	Red	Red	Red	Green	Green	Red	Red	Red

# The aim

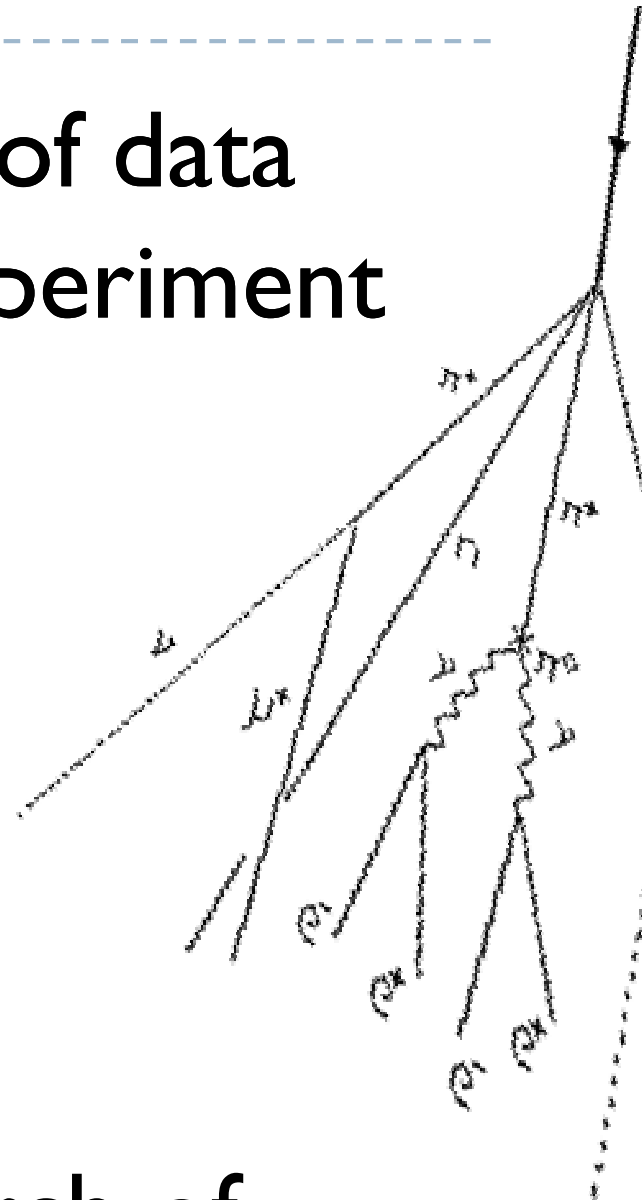
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Bring worldwide Internet users to the analysis of data constantly accumulated in the course of real experiment in the field of research of cosmic rays.

## ...and objectives

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- ▶ to make fundamental science more popular and encouraged by the society;
- ▶ to reduce the gap between the objects of research of modern science and the awareness level of the society;
- ▶ to perform scientific research at RUSALKA facility with the broad involvement of the Internet users.

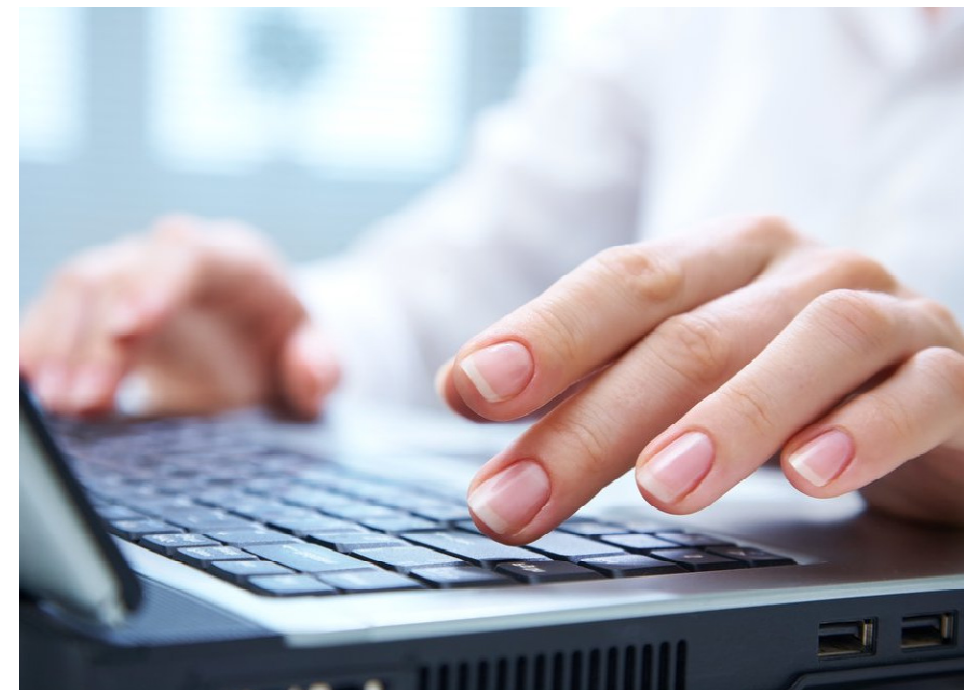




# The main audience

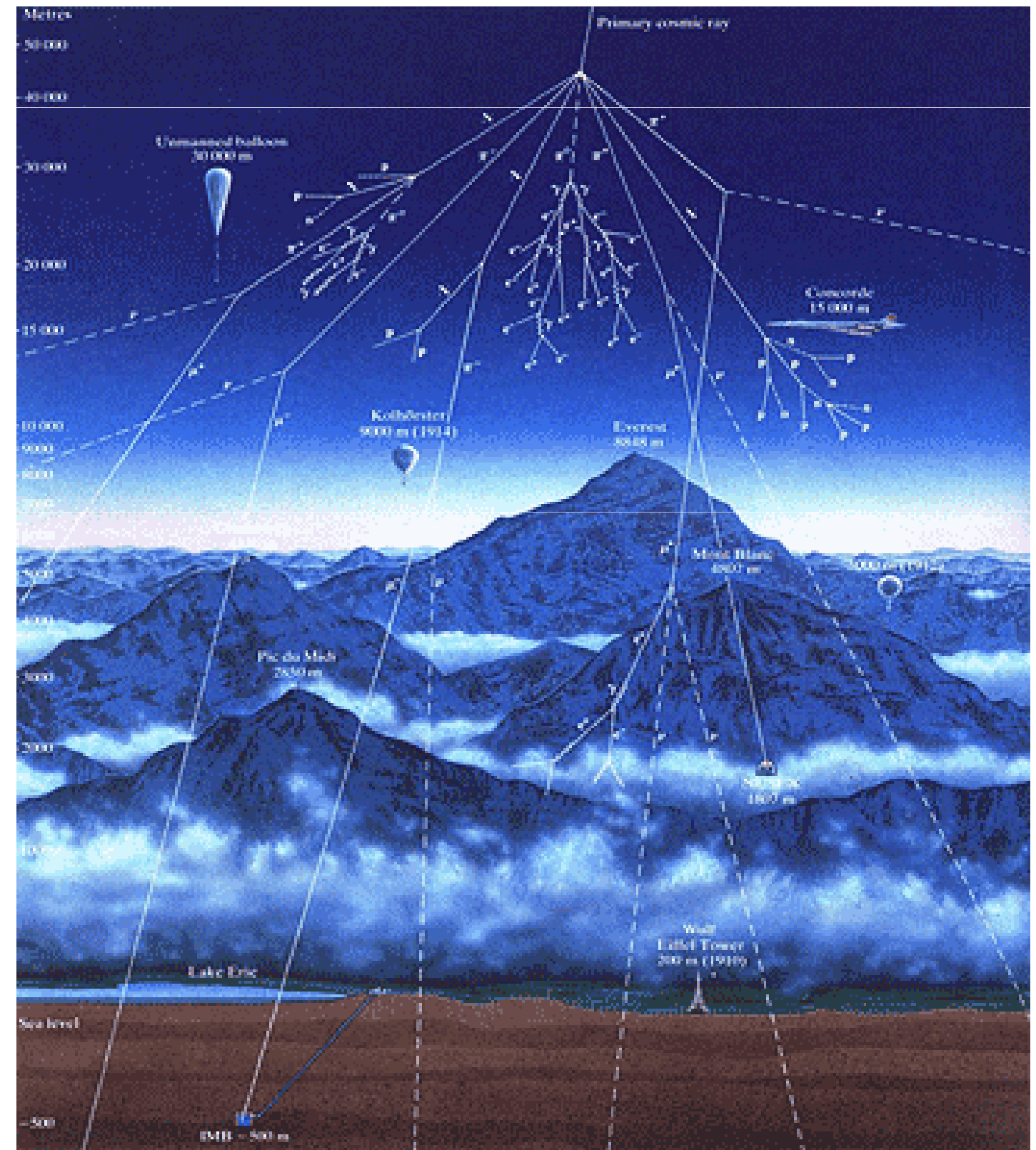
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- ▶ Middle and high school students committed to physics;
- ▶ Undergraduate students of university physics departments;
- ▶ Any keen Internet users



# Why cosmic rays?

- ▶ they are relevant for introduction into a wide range of trends in modern fundamental science;
- ▶ they make it possible to constantly accumulate big stats with minimal expenses for hardware and comparatively simple software for the analysis;
- ▶ it is simple enough to understand the idea and perform first experiments.



# “Livni” educational tasks

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## ► Physics and Astrophysics

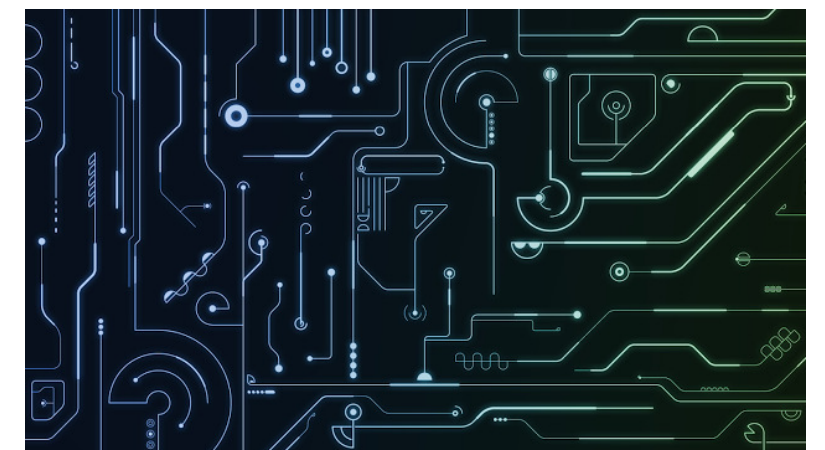
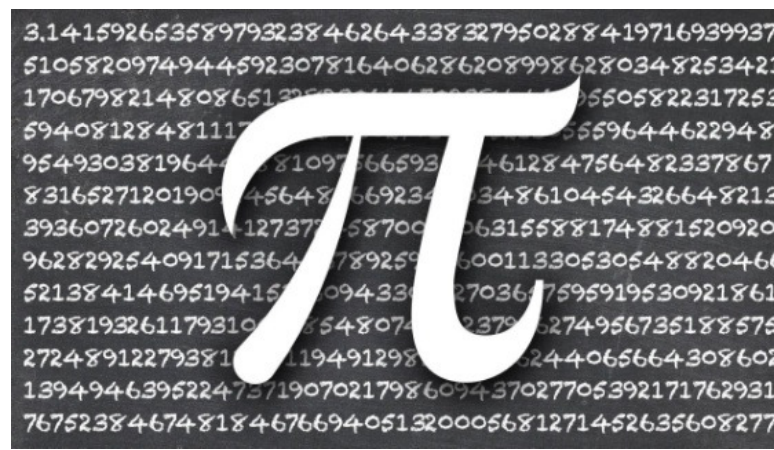
- Cosmic rays (cosmology);
- Elementary particles;
- Methods of data analysis
- Particle detectors
- General physics

## ► Mathematics

- Random variables
- Probability theory
- Mathematical statistics

## ► Technology

- GPS/GLONASS
- Basics of microelectronics





# “Livni” scientific tasks



- ▶ Monitoring of broad atmospheric showers;
- ▶ Search for space- or time-correlated showers (nuclear dissociation, interaction with cosmic micro-objects like dust or meteorites, etc.).

# Features

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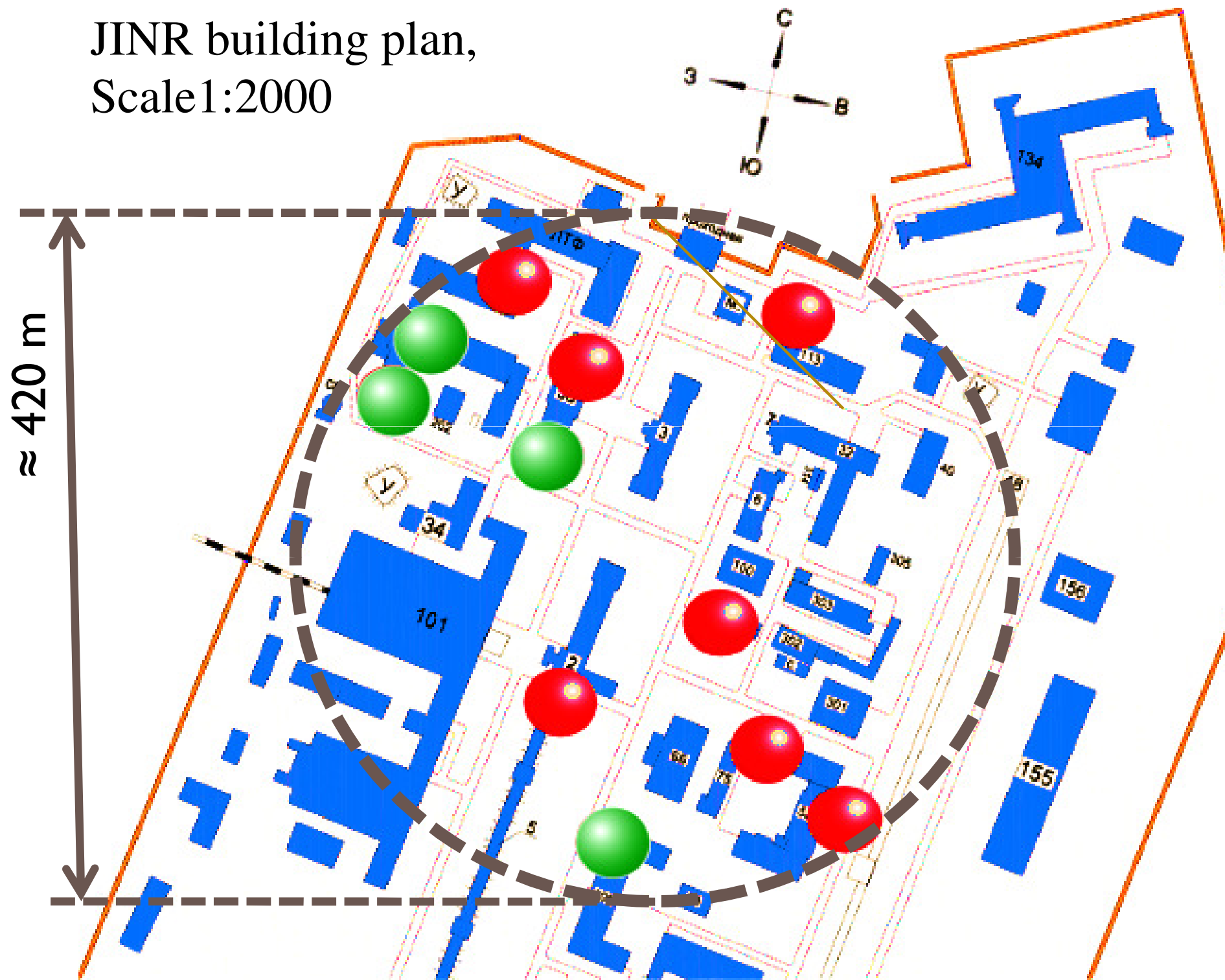
- 1) **Detector stations form a compound cluster on the territory of a scientific center**
  - ▶ simplifies maintaining the equipment
  - ▶ increases efficiency of data accumulation and shower registration
  - ▶ expands the number of potential participants
- 2) **Cellular structure of the facility simplifies**
  - ▶ adding new stations to the cluster
  - ▶ introducing new clusters
- 3) **Unique interactive internet-portal**
  - ▶ beginners can immediately start analyzing data using pre-made patterns
  - ▶ experts have an opportunity to create and share their own algorithms



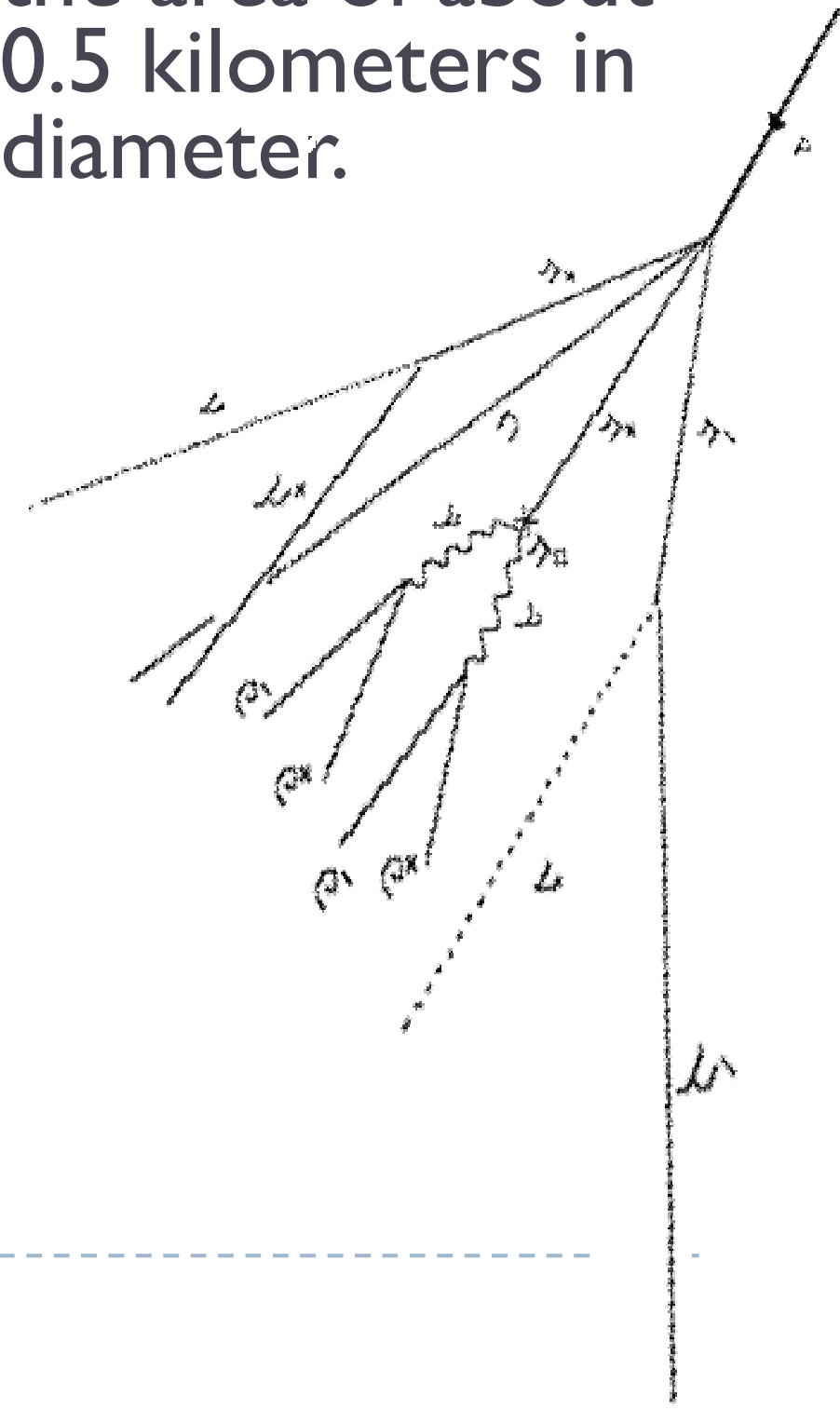


## RUSALKA (MERMAID)

JINR building plan,  
Scale 1:2000

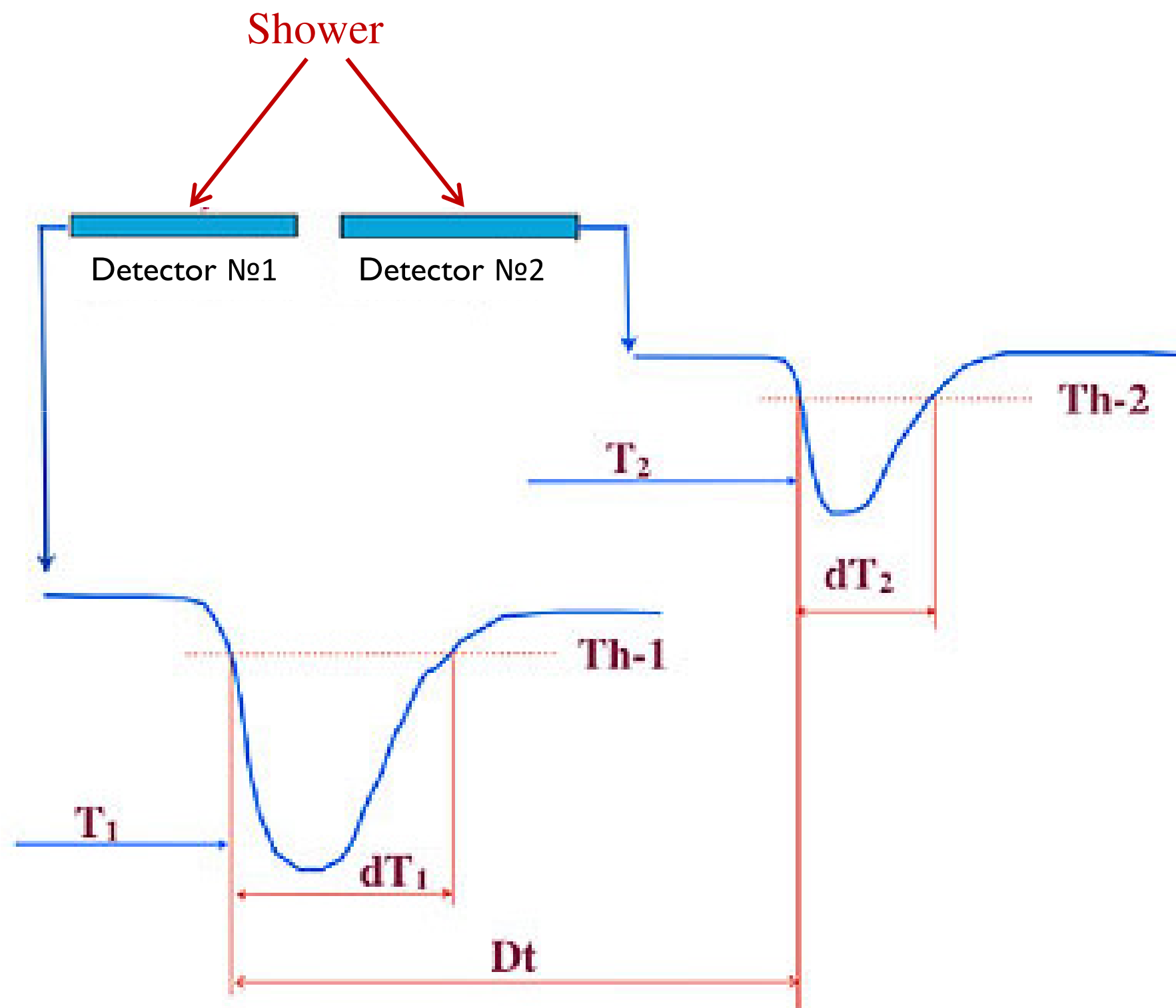


RUSALKA facility now consists of 11 workstations. It is located inside JINR buildings in the area of about 0.5 kilometers in diameter.



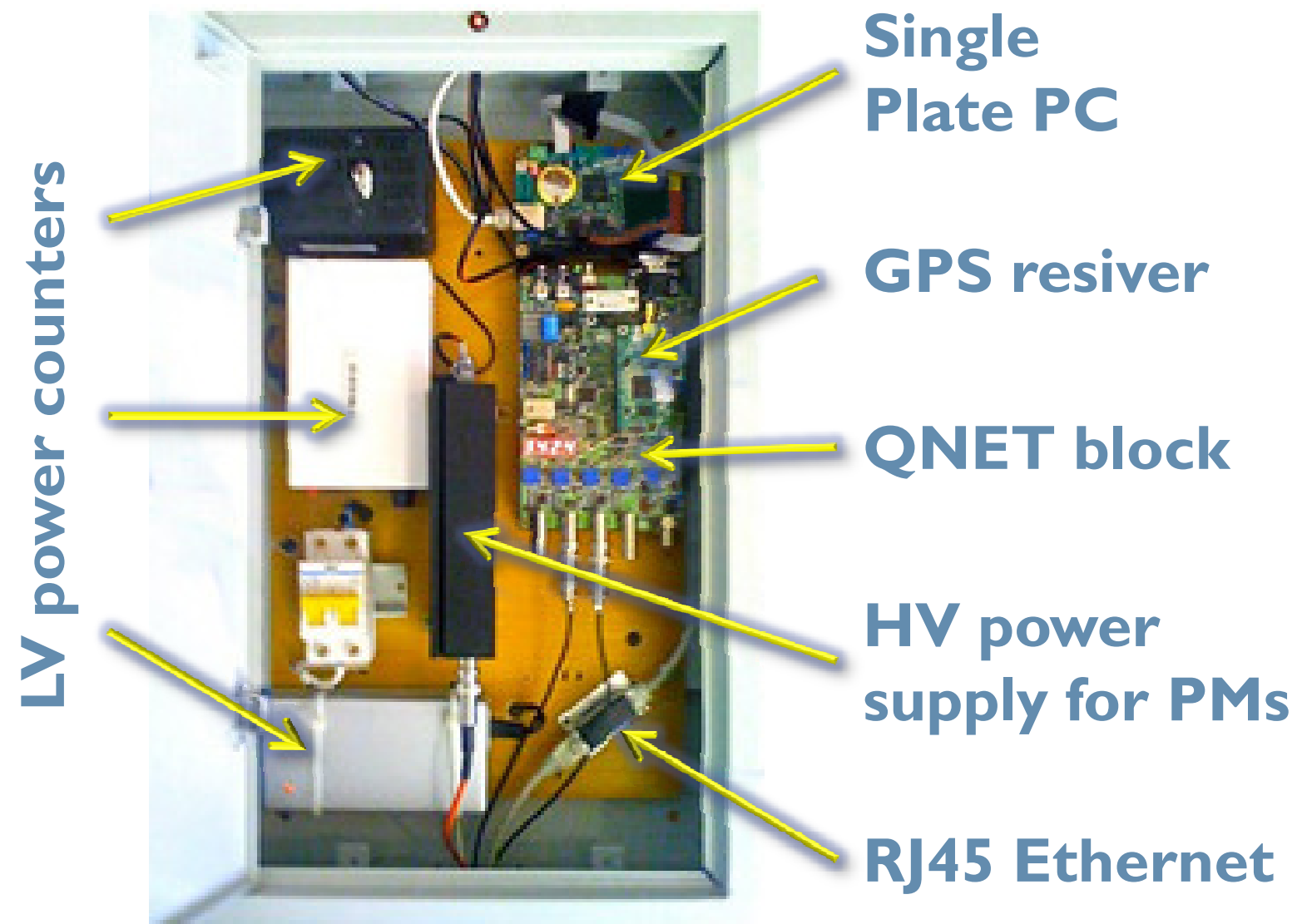
# How data is measured

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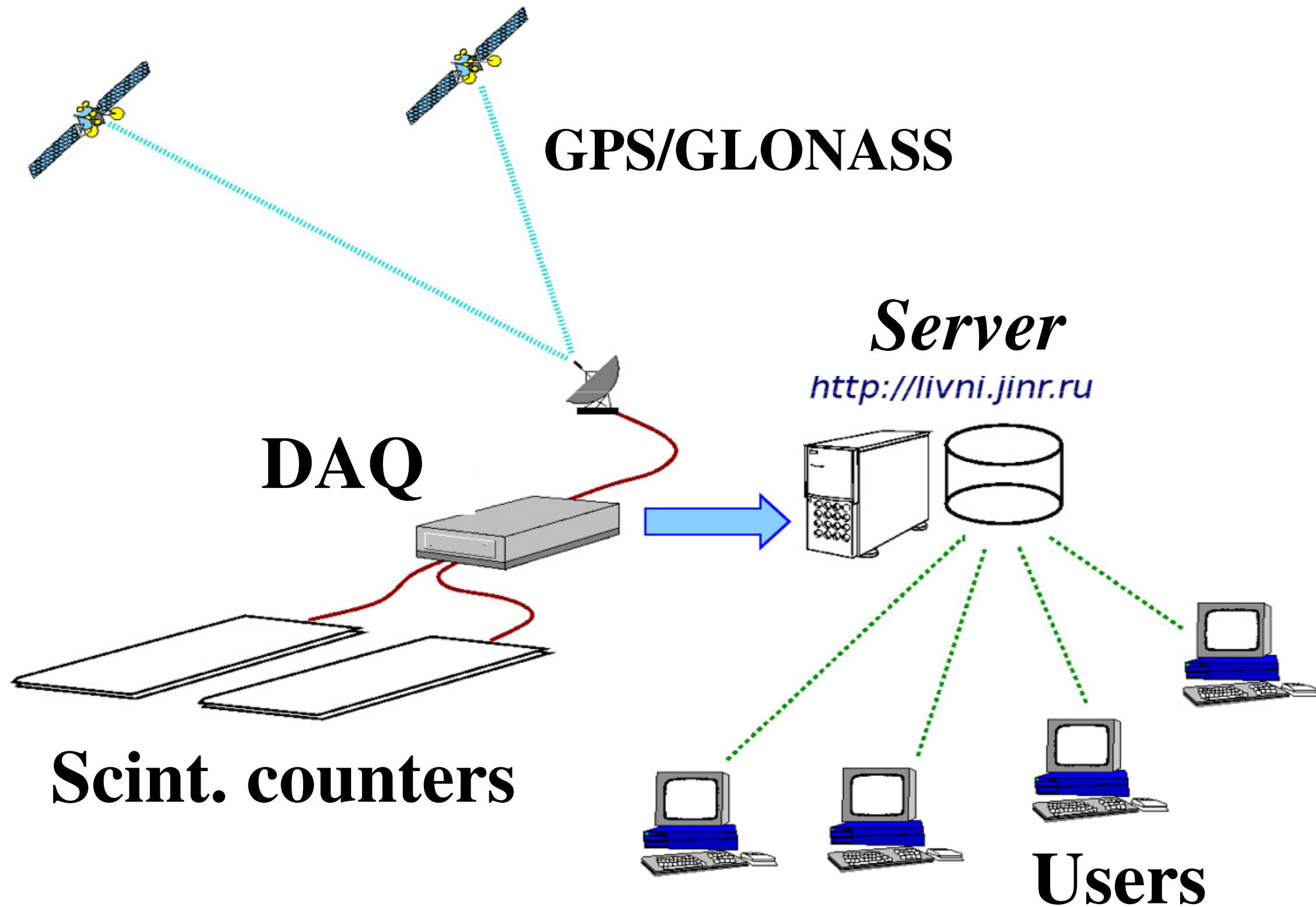
# Each workstation consists of:

- ▶ two scintillation counters;
- ▶ global positioning system receiver GPS or GLONASS;
- ▶ the electronic unit for formation and entering data into computer, which is supposed to have an access to the Internet.



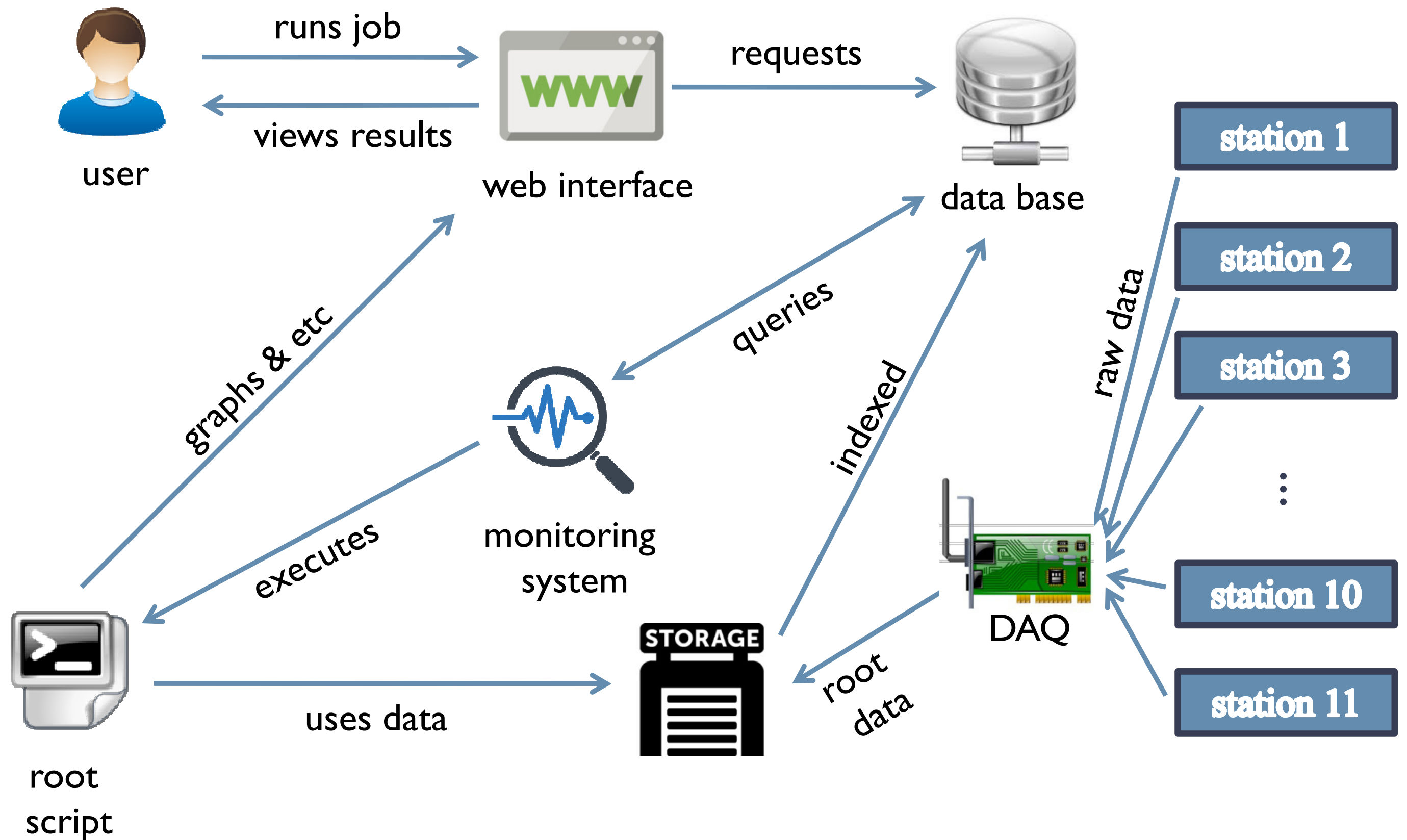
# Principal work scheme

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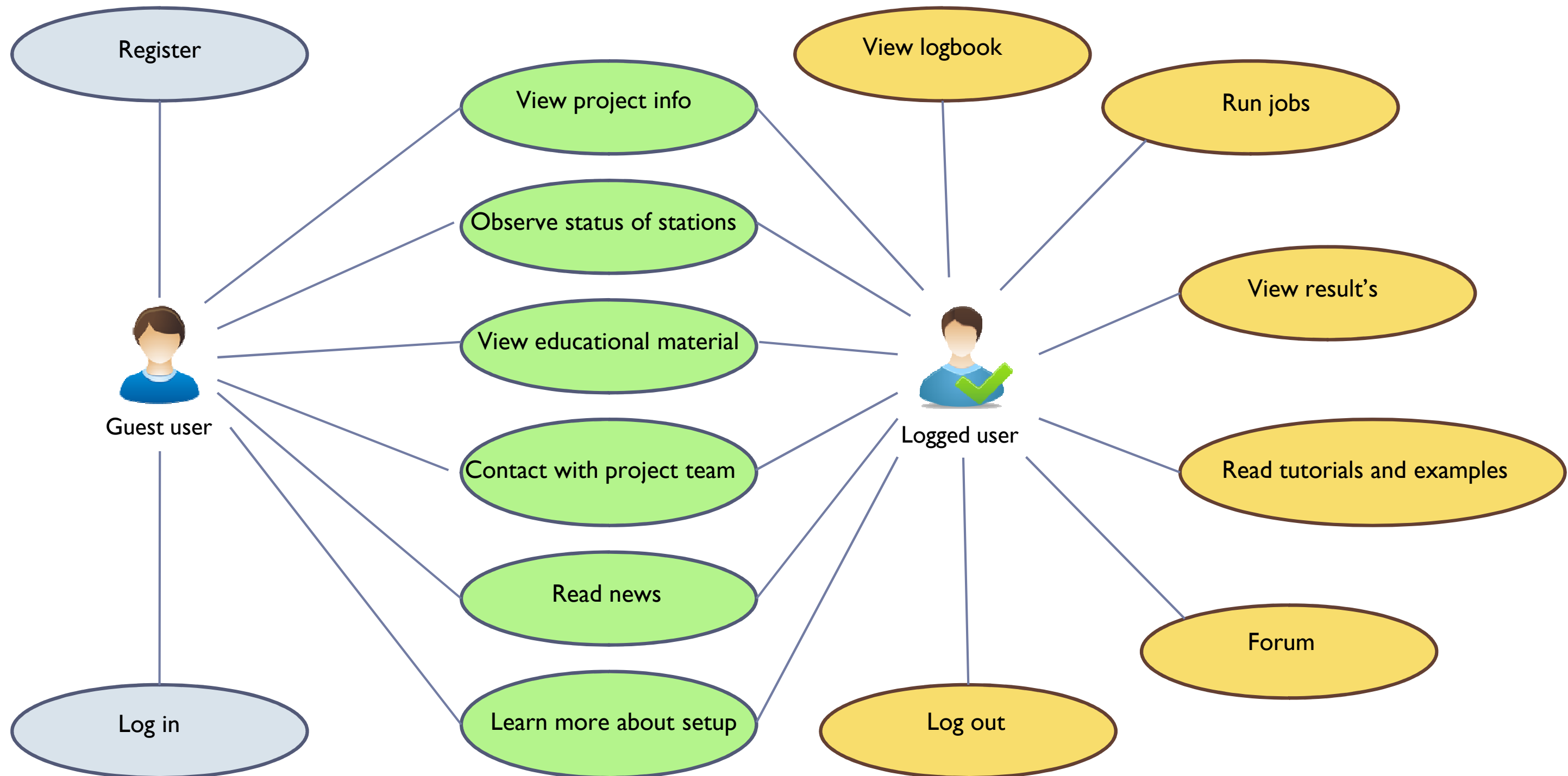




# Job running




# Portal's user interface




# Running an analysis job

<http://livni.jinr.ru>

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New job creation

*"Solving tasks in this project is like playing gammas for a musician or like trenings for an athlete. The more you follow them, the faster will be able to decide to begin serious scientific problems". © G.A. Chelkov*

In this section is task list with descriptions rated by complexity: easy ★, intermediate ★★, expert ★★★.


You can choose one and run it by click on title.


★	Task	Description	Note
★	<a href="#">Rate(time)</a>	<a href="#">Counting rate versus astronomical time</a>	Time dependance of counting rate for selected station
★	<a href="#">dT in one station</a>	<a href="#">Time interval between signals in two counters of selected station distribution for selected time interval.</a>	The results of this analysis are essential for understanding how the events by class "A" and "B" are selected and are used for of station operation quality control.
★	<a href="#">N_satellites(time)</a>	<a href="#">Time dependence of GPS satellites numbers recognized by selected station at selected time interval.</a>	This is one of service task. It help you to learn more about the quality of the GPS system, which operates more accurate, more satellites at the same time it sees.
★	<a href="#">N_satellites distribution</a>	<a href="#">Number of satellites distribution have been GPS recognized by selected station at selected time interval.</a>	This is one of service task.
★	<a href="#">Rate for classes A and B for different stations</a>	<a href="#">This task can plot the ratio of signal frequency of type «A» and «B» events at any combinations (A/A;A/B;B/A;B/B) for two selected stations and time intervals.</a>	This task is a one from the series of tasks related with investigation of the rate-time dependance of signals at working stations and give to one the possibility to check how any effects in question appeared at different stations.
★	<a href="#">Rate(time) with Meteo</a>	<a href="#">This task gives the possibility to see as the counting rate of selected station(s) at selected time interval as a behavior of atmospheric parameters.</a>	Task is very useful at the beginning of Rate(time)/Atmospheric parameters correlation study.
★	<a href="#">Rate(time) for classes A and B</a>	<a href="#">Time dependence of counting rate of selected station at selected time interval for events classes A and B.</a>	Task similar to Rate(time) one, but more informative and present the results about "good"(A) and "background" (B) events separately.
★★	<a href="#">Time resolution and offset for one station</a>	<a href="#">Average time interval between signals in two detectors of the same selected station (dt) and width of this distribution (the time resolution) σdt during the specified period of time.</a>	This task is continuation of task «dT in one station»




# Running an analysis job

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## Enter parameters



Rate(time)

Enter calendar dates in format: MM-DD-YYYY HH:MM (not earlier than 05-07-2009).  
Max supported number of bins is 10000.

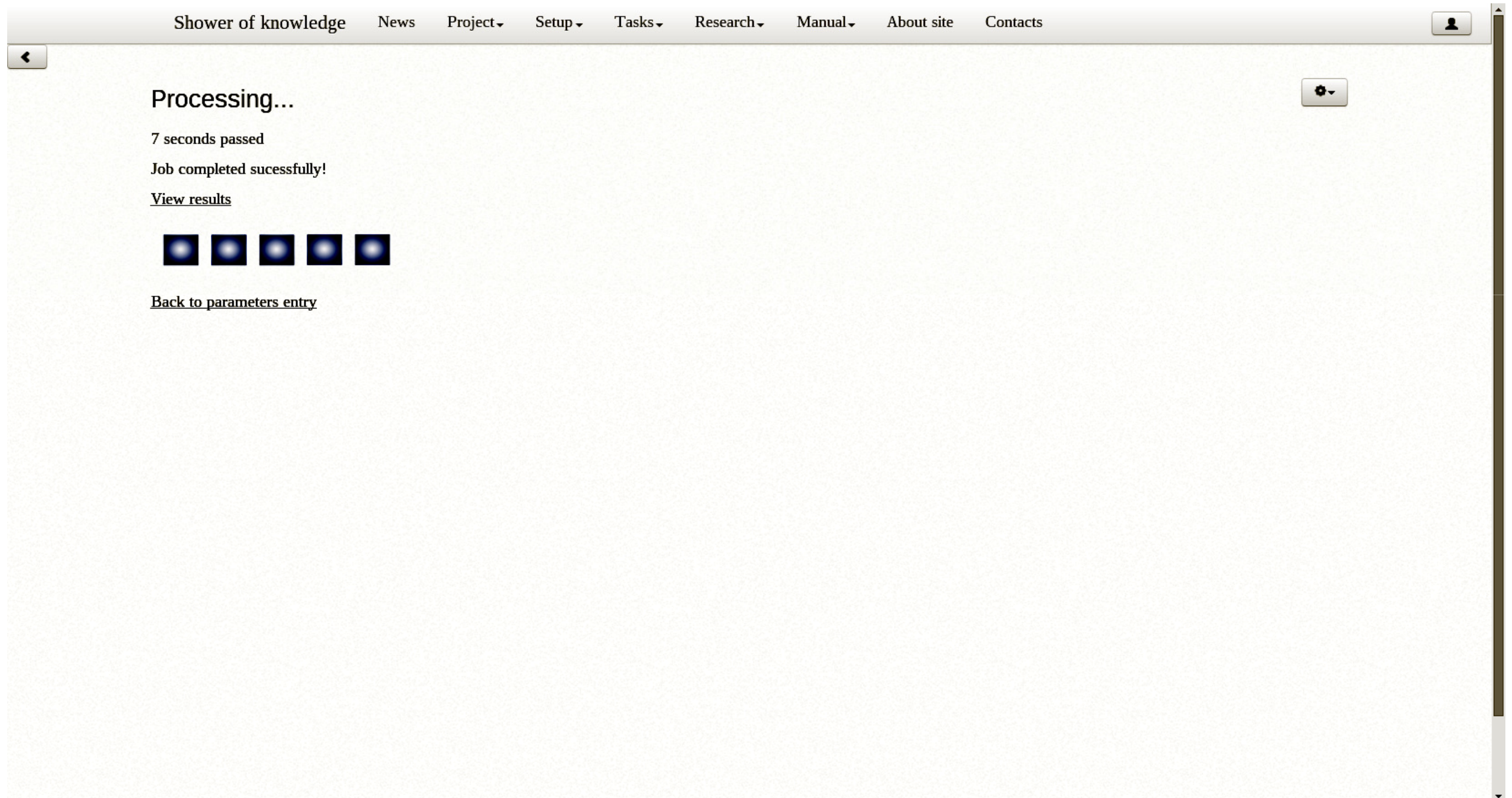
Property	Value
Select data from	<input type="text" value="02.02.2017"/> <input type="text" value="00:00"/>
Select data until	<input type="text" value="09.02.2017"/> <input type="text" value="17:19"/>
On/Off all	<input checked="" type="checkbox"/>
Use station 1	<input checked="" type="checkbox"/>
Use station 2	<input checked="" type="checkbox"/>
Use station 3	<input checked="" type="checkbox"/>
Use station 4	<input checked="" type="checkbox"/>
Use station 5	<input checked="" type="checkbox"/>
Use station 6	<input checked="" type="checkbox"/>
Use station 7	<input checked="" type="checkbox"/>
Use station 8	<input checked="" type="checkbox"/>
Use station 9	<input checked="" type="checkbox"/>
Use station 10	<input checked="" type="checkbox"/>
Use station 11	<input checked="" type="checkbox"/>
Number of bins in the histogram	<input type="text" value="100"/>
Coincidence rank	<input type="text" value="0"/>
Comments	<input type="text" value="Your note"/>

 **Lets go!**



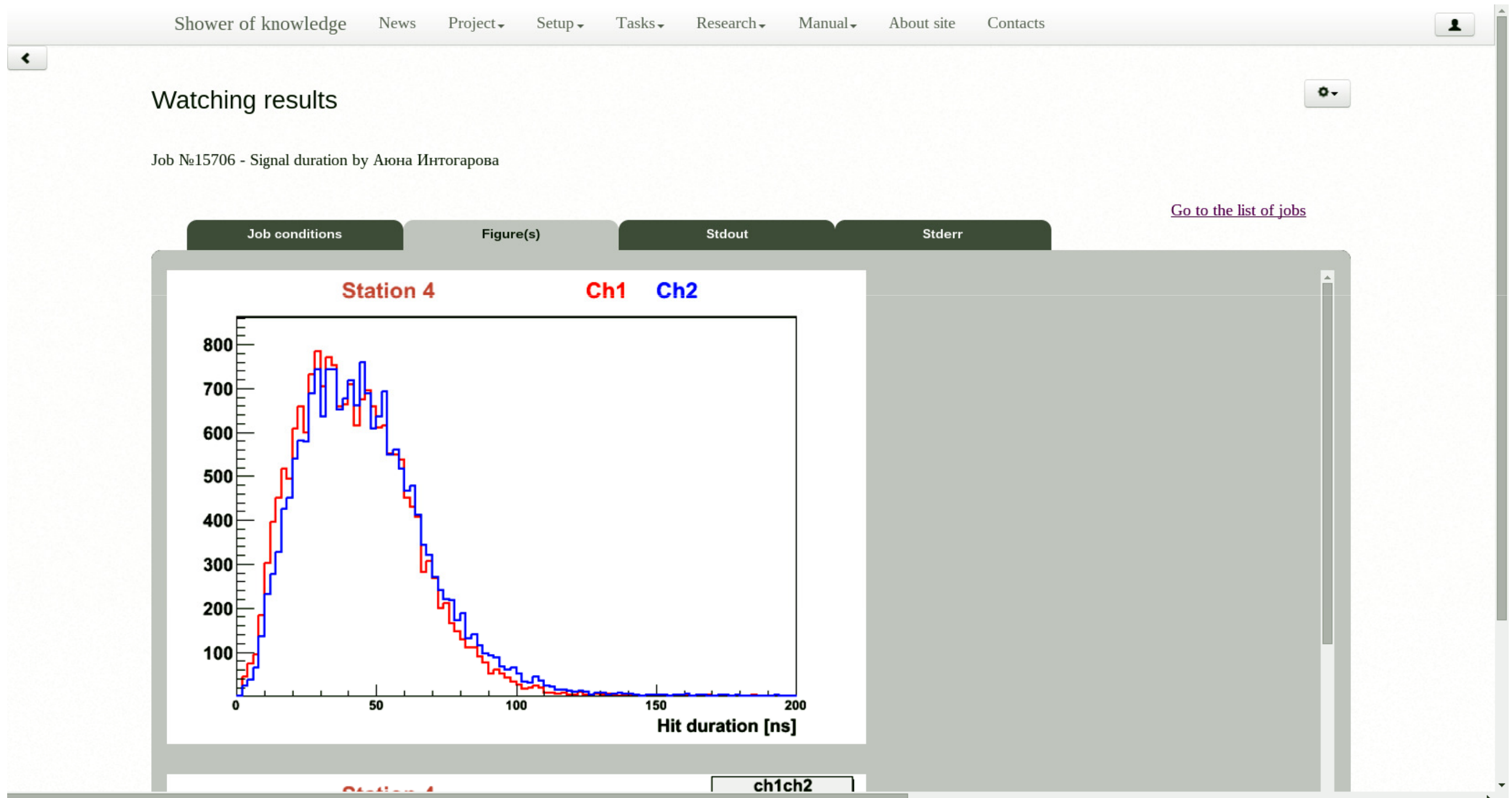
# Running an analysis job

<http://livni.jinr.ru>



# Running an analysis job


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List of jobs 

Click on job ID to see results of running.  
Description of task can be available by clicking on it's caption.

By numberBy dateBy job IDBy task captionBy user name









Show records from01.03.201600:00till09.02.201717:22

Ok

ID	Task	Status	User	Started	Finished		Comment
<a href="#">15711</a>	<a href="#">Signal duration</a>	completed	Аюна Интогарова	2016-05-25 16:36:02	2016-05-25 16:36:02	3 140312	
<a href="#">15710</a>	<a href="#">Signal duration</a>	completed	Аюна Интогарова	2016-05-25 16:31:01	2016-05-25 16:31:02	3 140212	
<a href="#">15709</a>	<a href="#">Signal duration</a>	completed	Аюна Интогарова	2016-05-25 16:30:02	2016-05-25 16:30:10	3 260112	
<a href="#">15708</a>	<a href="#">Signal duration</a>	completed	Аюна Интогарова	2016-05-25 16:29:01	2016-05-25 16:29:09	3 250112	
<a href="#">15707</a>	<a href="#">Signal duration</a>	completed	Аюна Интогарова	2016-05-25 16:28:02	2016-05-25 16:28:09	240112 3	
<a href="#">15706</a>	<a href="#">Signal duration</a>	completed	Аюна Интогарова	2016-05-25 16:26:02	2016-05-25 16:26:02	4 250112	
<a href="#">15705</a>	<a href="#">Rate(time)</a>	completed	Аюна Интогарова	2016-05-25 16:20:02	2016-05-25 16:20:09	3 240112	
<a href="#">15704</a>	<a href="#">Signal duration</a>	completed	Аюна Интогарова	2016-05-25 16:17:01	2016-05-25 16:17:09	240112 4	
<a href="#">15703</a>	<a href="#">Signal duration</a>	completed	Аюна Интогарова	2016-05-25 16:11:01	2016-05-25 16:11:02	4 010110	
<a href="#">15702</a>	<a href="#">Signal duration</a>	completed	Аюна Интогарова	2016-05-25 16:02:02	2016-05-25 16:02:02	4 231213	
<a href="#">15701</a>	<a href="#">Signal duration</a>	completed	Аюна Интогарова	2016-05-25 15:57:01	2016-05-25 15:57:02	st4 141112	
<a href="#">15700</a>	<a href="#">Signal duration</a>	completed	Аюна Интогарова	2016-05-22 16:25:02	2016-05-22 16:25:03	проверка	
<a href="#">15699</a>	<a href="#">N satellites(time)</a>	completed	ЕЛЕНА ВОЛОДЧЕНКОВА	2016-05-19 23:21:01	2016-05-19 23:21:02	--	
<a href="#">15698</a>	<a href="#">Rate(time)</a>	completed	ЕЛЕНА ВОЛОДЧЕНКОВА	2016-05-19 23:13:01	2016-05-19 23:13:15	--	
<a href="#">15697</a>	<a href="#">Rate(time)</a>	completed	Коновалова Таисия	2016-05-06 12:49:02	2016-05-06 13:00:40	--	
<a href="#">15696</a>	<a href="#">Rate(time)</a>	completed	Коновалова Таисия	2016-05-06 12:44:02	2016-05-06 12:57:23	--	
<a href="#">15695</a>	<a href="#">Rate(time)</a>	completed	Коновалова Таисия	2016-05-06 12:44:02	2016-05-06 12:57:23	--	
<a href="#">15694</a>	<a href="#">Rate(time)</a>	completed	Коновалова Таисия	2016-05-06 12:40:02	2016-05-06 12:41:19	--	
<a href="#">15693</a>	<a href="#">Rate(time)</a>	completed	Коновалова Таисия	2016-05-06 12:28:02	2016-05-06 12:28:10	--	
<a href="#">15692</a>	<a href="#">Rate(time)</a>	completed	Коновалова Таисия	2016-05-06 12:26:02	2016-05-06 12:26:03	--	
<a href="#">15691</a>	<a href="#">Rate(time)</a>	completed	Коновалова Таисия	2016-05-06 12:21:01	2016-05-06 12:21:02	--	

# Project statistics

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- ▶ Project started in 2006, the portal was launched in 2010
- ▶ Languages:     
- ▶ Number of site views - 334881 
- ▶ Registered users - 571 
- ▶ 10436 executed jobs 
- ▶ Active users (> 30 logins) ~ 40 



# Outreach work

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- ▶ JINR University Centre;
- ▶ JINR Science Museum;
- ▶ “Poisk” (Search) school centre, Stavropol;
- ▶ Summer school “Modern Physics”;
- ▶ JINR Science Festival;
- ▶ Videoconference with students of Moscow schools 2073, 1788, 1391, 2075, 2083, 1392 - February 29, 2016.



# Perspectives

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- ▶ Each new station enhances the scientific significance of the analysis
- ▶  $K > \sim 10$  clusters,  $N > \sim 100$  stations: global super detector for rare showers of super-high energies  $> 10^{19}$  eV

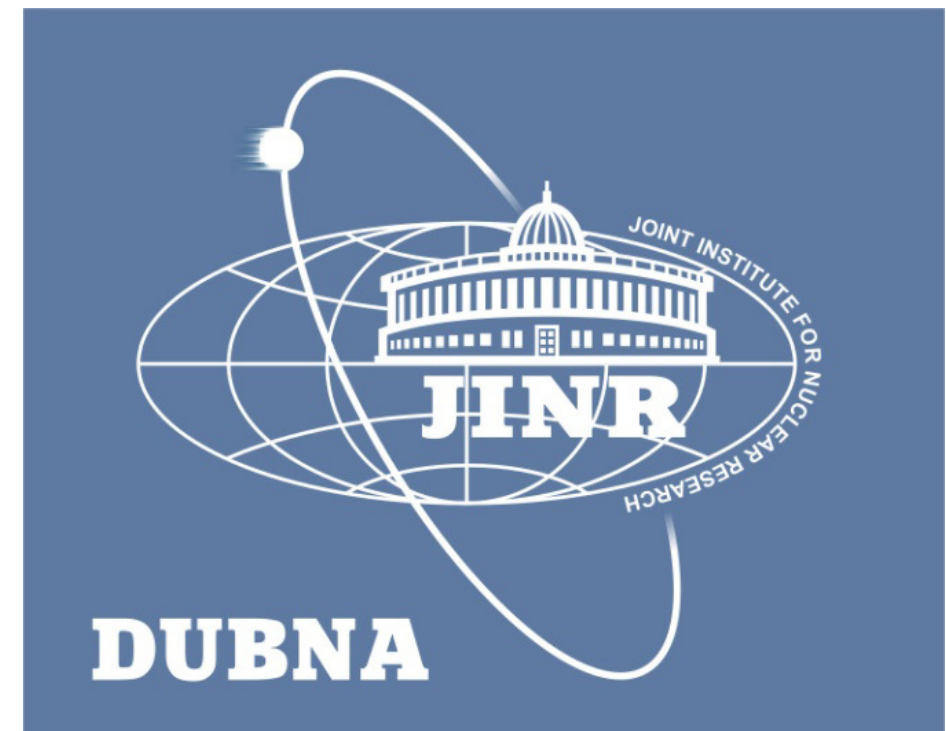




# Cooperation

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- ▶ Developed and implemented by
  - Laboratory of Nuclear Problems, Joint Institute for Nuclear Research (Dubna, Russia)
- ▶ Partnership with
  - Callio Lab (Pyhäjärvi, Finland)
- ▶ Interested in ways of cooperation
  - Creating new data-analysis tasks
  - Deploying new stations
  - Data exchange
  - Site localization
  - Attracting new students





Thank you for your attention!

Any questions?