

# NATIONAL RESEARCH CENTER “KURCHATOV INSTITUTE”. CURRENT STATE AND PERSPECTIVES

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## OUTLINE

- ◆ Introduction
- ◆ Kurchatov center of synchrotron radiation and nanotechnologies
- ◆ Research neutron source based on nuclear reactor IR-8
- ◆ Nanobio-technological center
- ◆ Center of data development

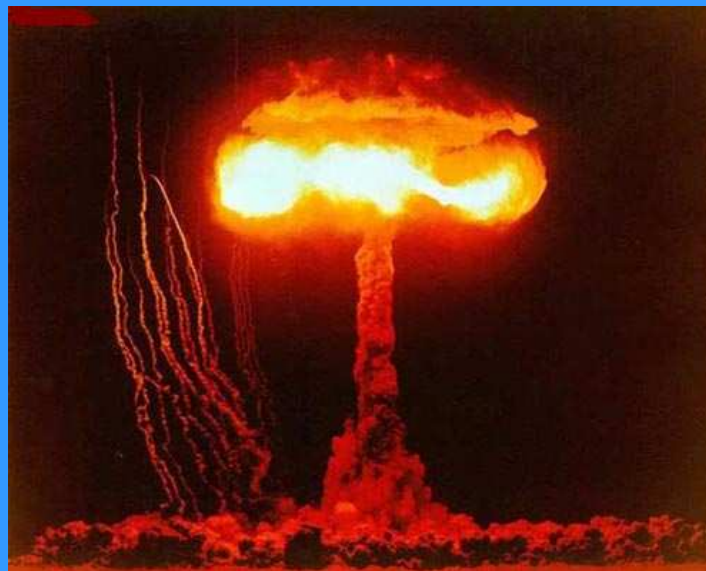


# INTRODUCTION

Institute was founded  
in 1943



I.V. Kurchatov  
Founder and first  
director of the institute



1949



1954



# INTRODUCTION

Nuclear power installations for submarines, icebreakers and  
cruisers





# INTRODUCTION

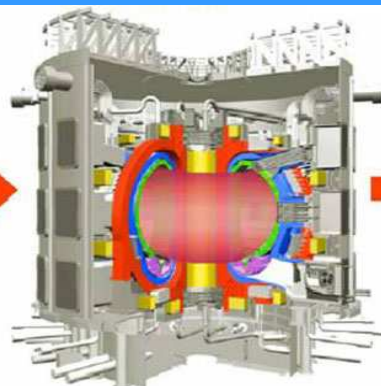
## Thermonuclear energy application

- ◆ RRC «Kurchatov institute» was an inventor of the conception of plasma system called TOKAMAK accepted by world community as a base for first thermonuclear reactors.
- ◆ RRC «Kurchatov institute» was an initiator of formation an international science-technical consortium which designed International Thermonuclear Experimental Reactor – ITER.

2007 г.



2016 г.



2030 г.



2050 г.

**Industrial  
thermonuclear  
plant**

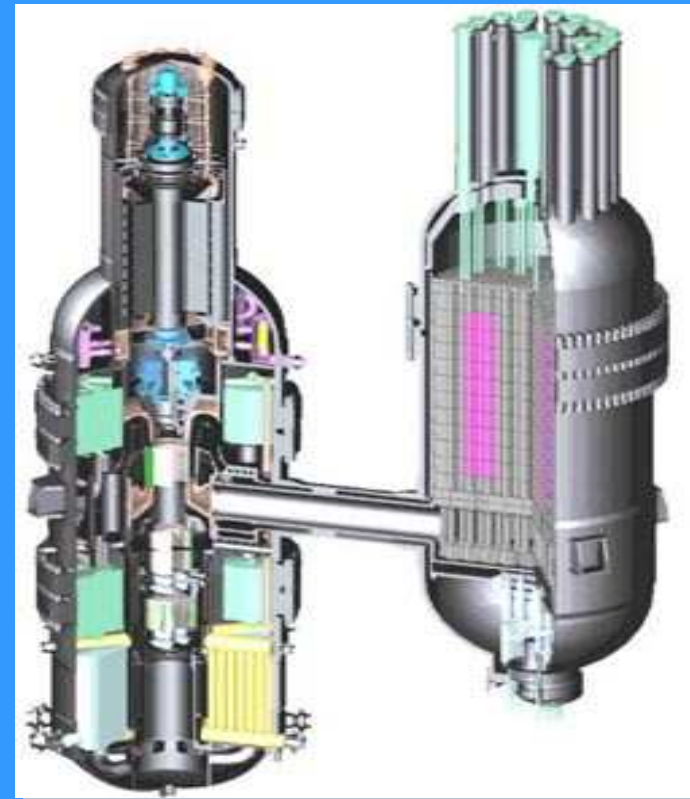
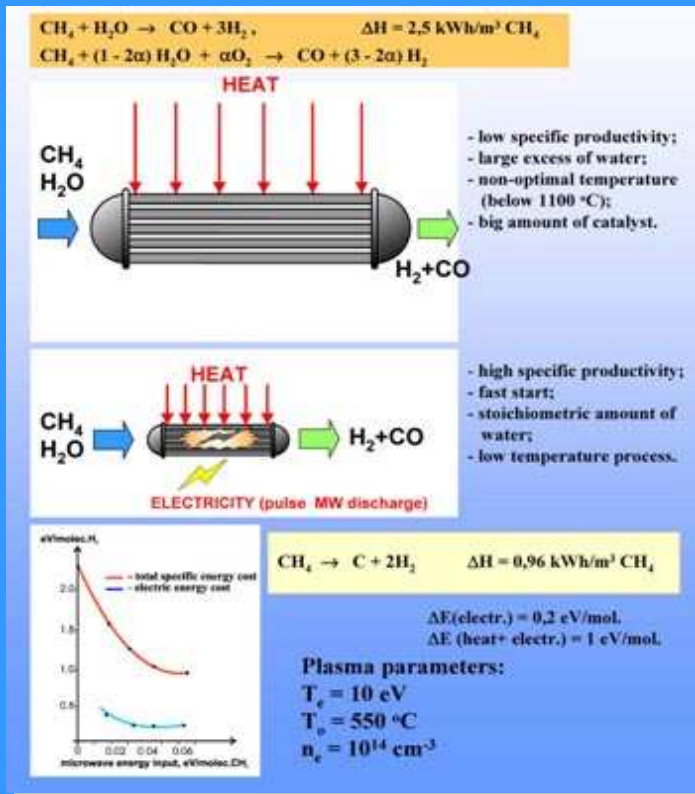


# INTRODUCTION

## Application of hydrogen for storage and production of energy

◆ Plasmachemical technique

◆ High temperature nuclear reactor





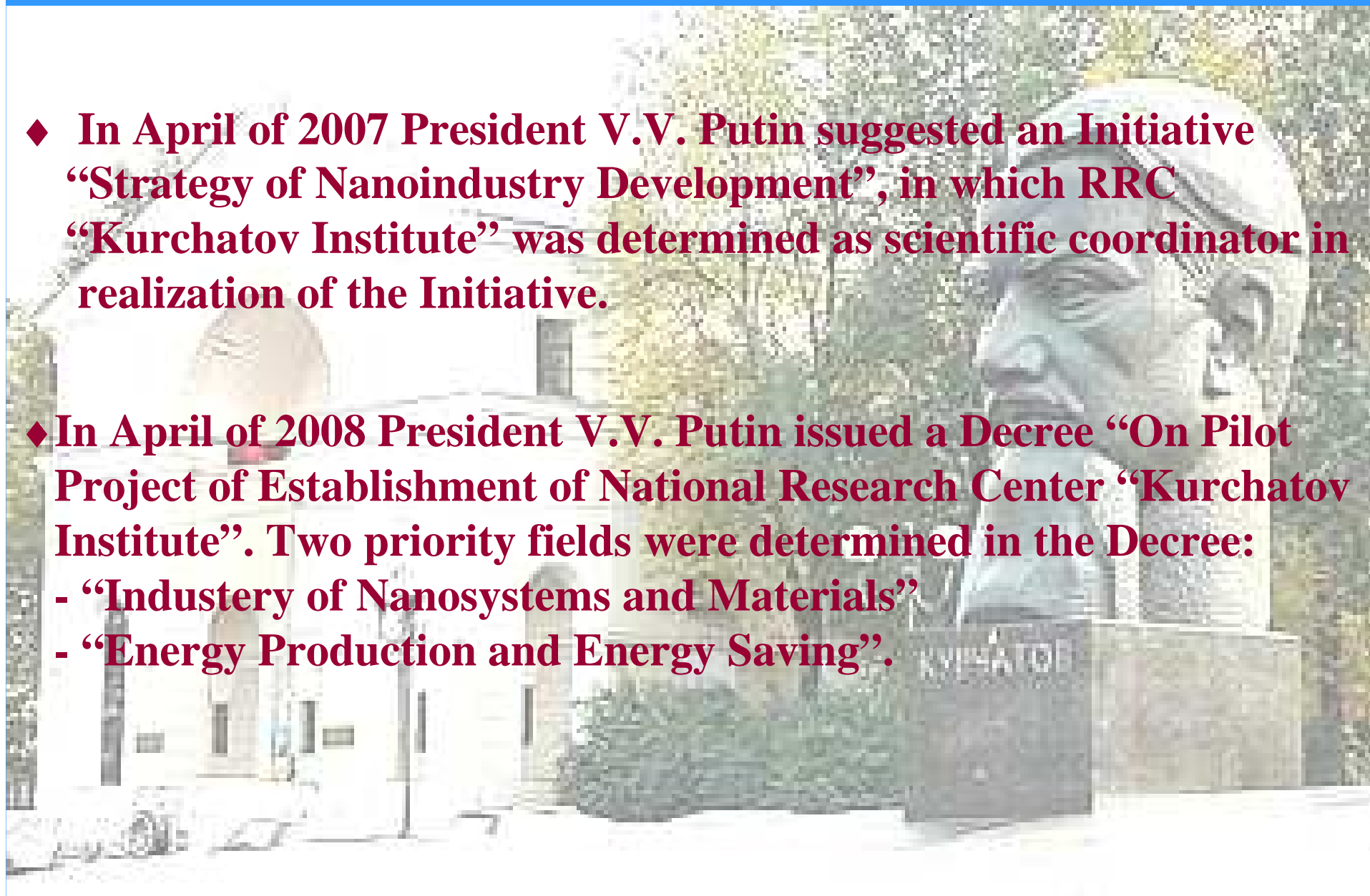
## INTRODUCTION

- ◆ RRC “Kurchatov institute” possesses a unique complex of experimental techniques for research and development in the field of nanotechnologies and nanomaterials. The complex includes the following facilities:
  - Kurchatov center of synchrotron radiation and nanotechnologies
  - Research neutron source based on nuclear reactor IR-8
  - Center of bionanotechnologies
  - Center of data development
- ◆ The complex received a name “The center of convergent nano-, bio-, info-, cognitive technologies (NBIC-center)”.
- ◆ The personal of RRC “Kurchatov institute” has a great experience in realization of multidisciplinary megaprojects.



# INTRODUCTION

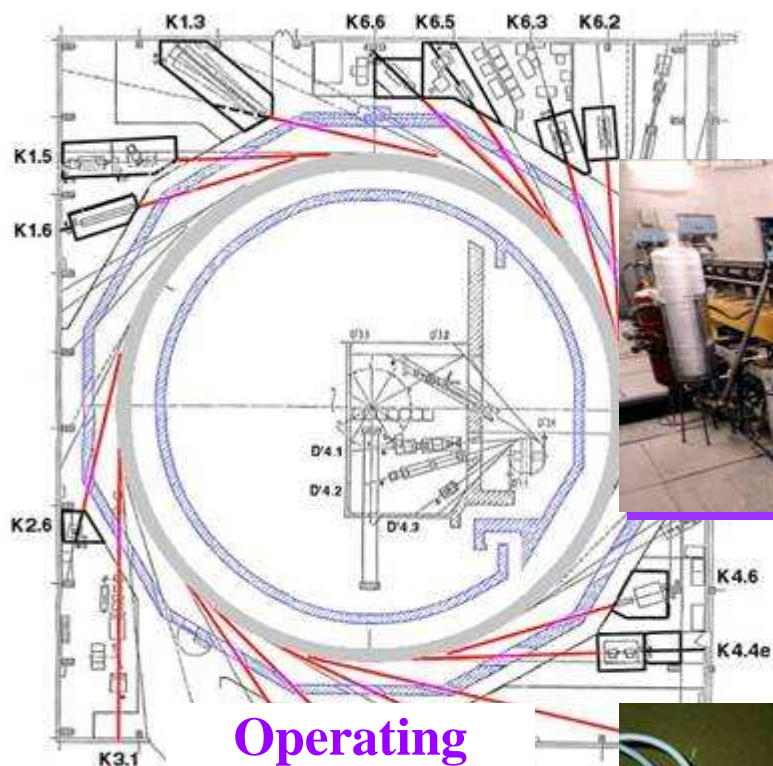
- ◆ In April of 2007 President V.V. Putin suggested an Initiative “Strategy of Nanoindustry Development”, in which RRC “Kurchatov Institute” was determined as scientific coordinator in realization of the Initiative.
- ◆ In April of 2008 President V.V. Putin issued a Decree “On Pilot Project of Establishment of National Research Center “Kurchatov Institute”. Two priority fields were determined in the Decree:
  - “Industry of Nanosystems and Materials”
  - “Energy Production and Energy Saving”.







# KURCHATOV CENTER OF SYNCHROTRON RADIATION AND NANOTECHNOLOGIES



Linear  
accelerator

Large  
storage ring



Small  
storage ring

Operating  
room





# KURCHATOV CENTER OF SYNCHROTRON RADIATION AND NANOTECHNOLOGIES

## Experimental stations

### X-ray diagnostics stations

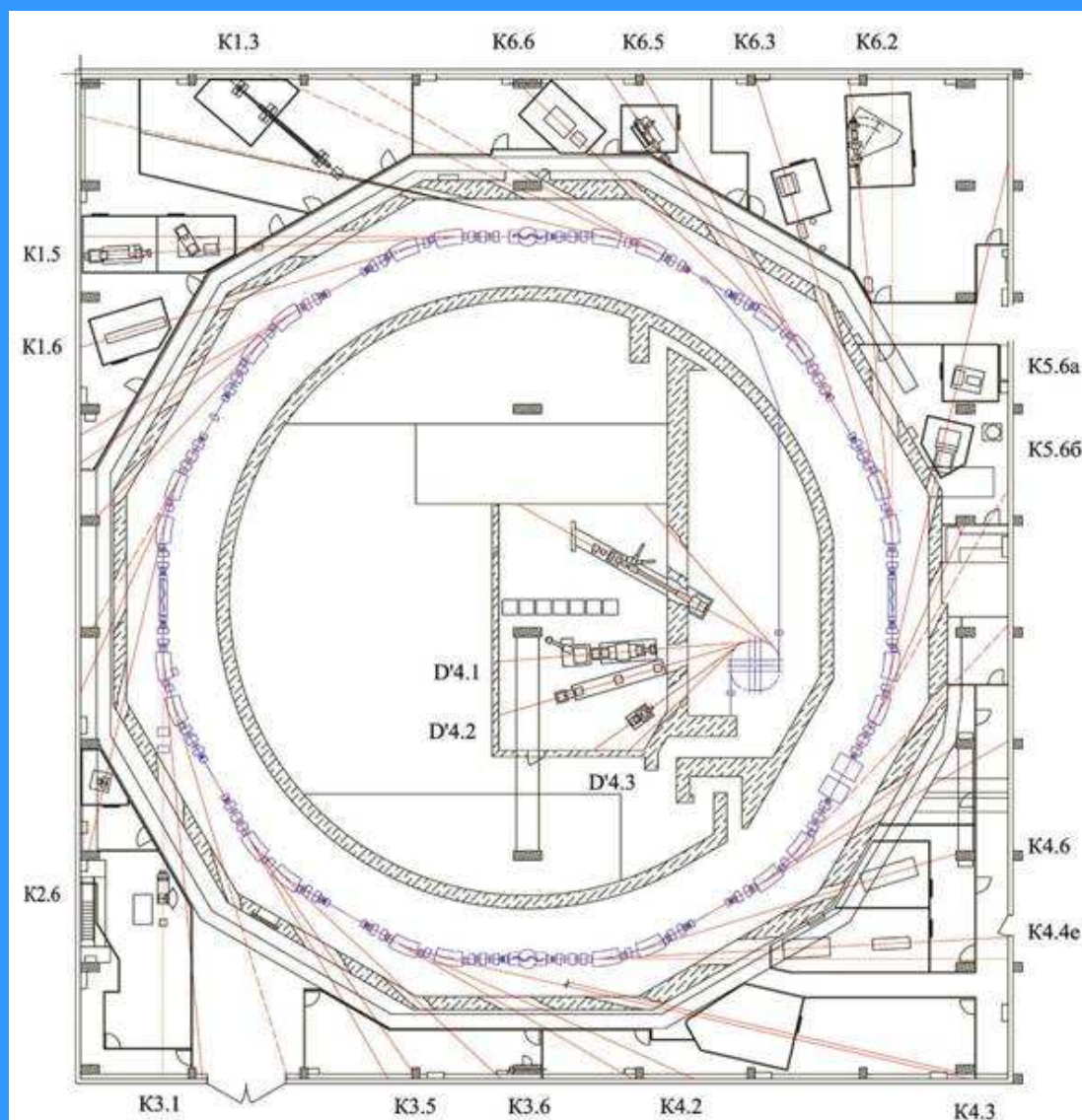
1	Protein Crystallography
2	Precise X-ray Optics
3	X-ray Crystallography and Material Science
4	Medical and Industrial Diagnostics
5	EXAFS
6	Small Angle Scattering
7	Time-Resolved Small-Angle Diffraction
8	Refraction optics
9	Diffraction topography and tomography

### VUV diagnostics stations

10	Photoelectron Spectroscopy
11	Optical Investigations of Dielectrics
12	VUV Luminescence and Absorption

### X-ray technological stations

13	Organic films (Lengmure-Blodgett)
14	Surface Investigations (Molecular Beam Epitaxy)
15	LIGA
16	Nanofab





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## Vacuum ultraviolet stations



photoelectron  
spectroscopy

$E \sim 3 \div 35 \text{ eV}$



VUV Luminescence  
and Absorption

$E \sim 3,5 \div 25 \text{ eV}$



Optical  
Investigations of  
Dielectrics

$E \sim 3 \div 40 \text{ eV (SN)}$   
 $E \sim 30 \div 200 \text{ eV (TMG)}$

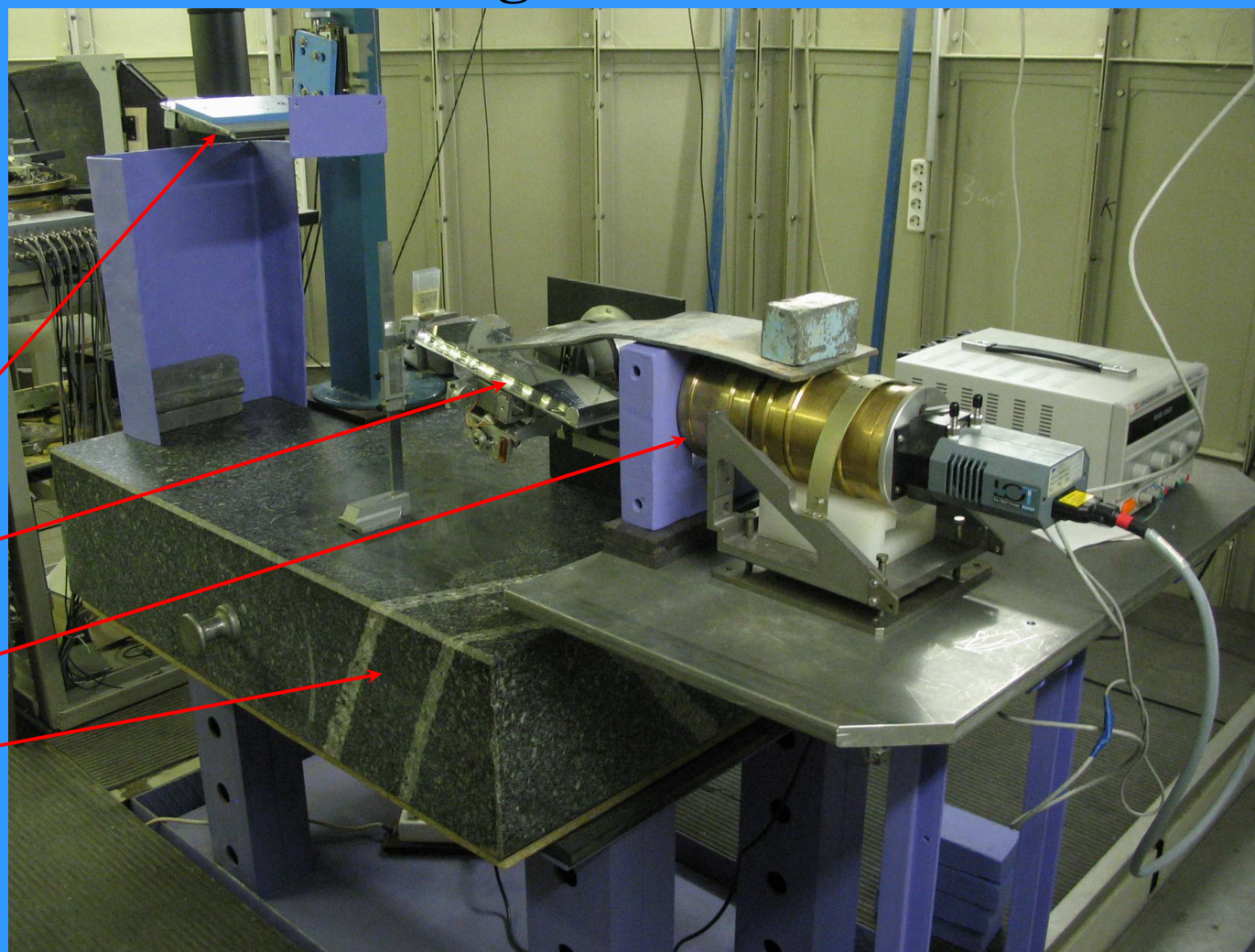


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## Station for medical diagnostics “Mediana”

Refraction  
imaging setup

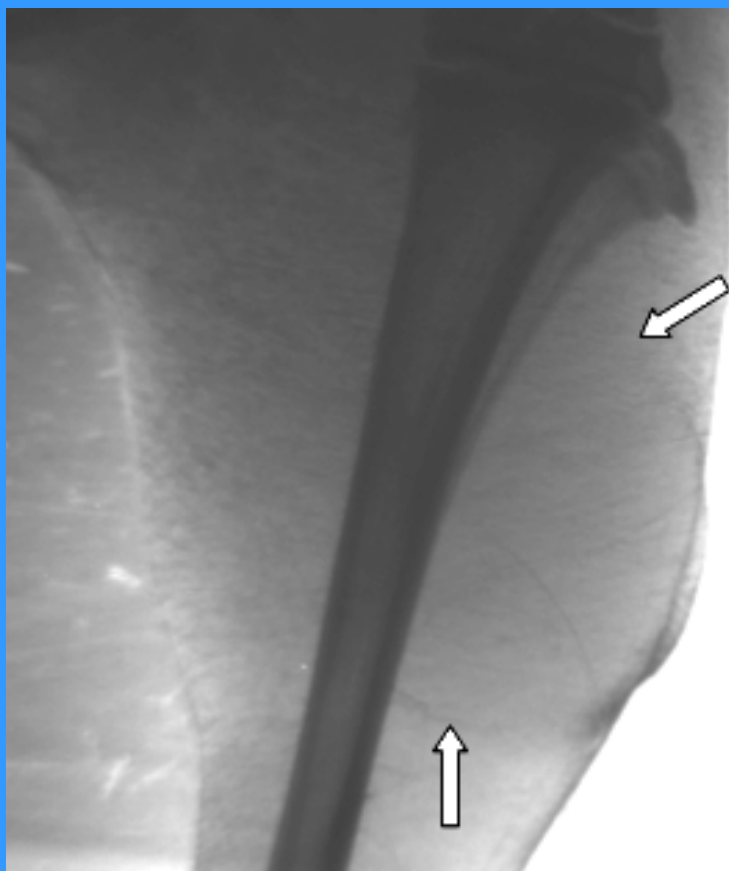
- 1- monochromator  
crystal,
- 2- analyzer crystal,
- 3- digital detector
- 4- antivibration  
table



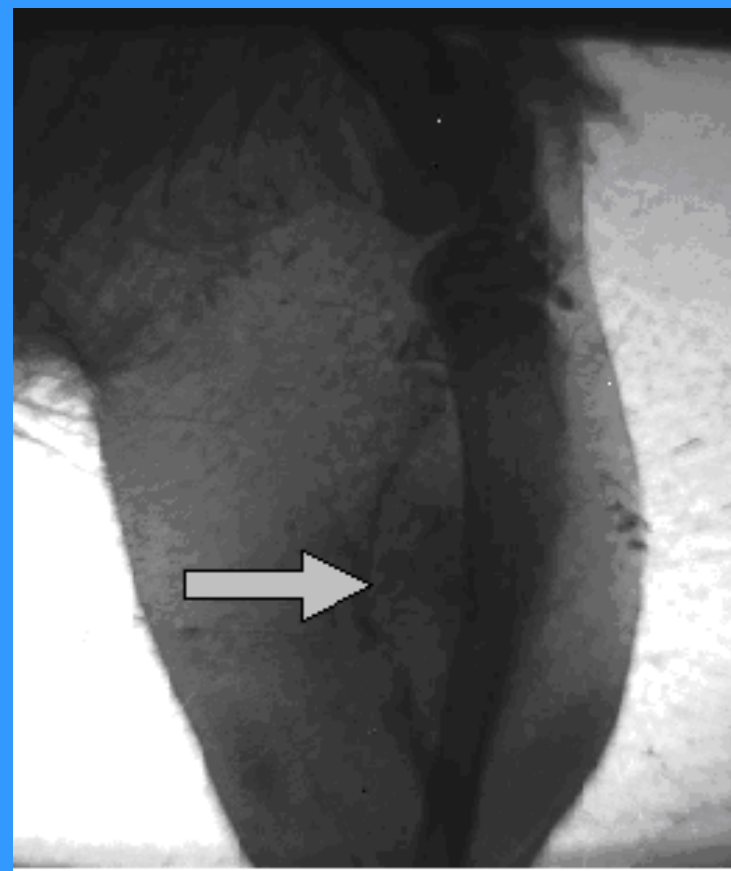


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## Cancer growth imaging



a



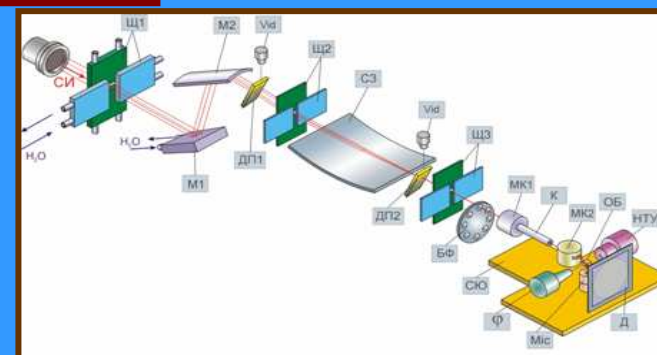
b

Sarcoma M1 growth in rat's shin: 7 day (a) and 14 day (b)



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## Protein crystallography

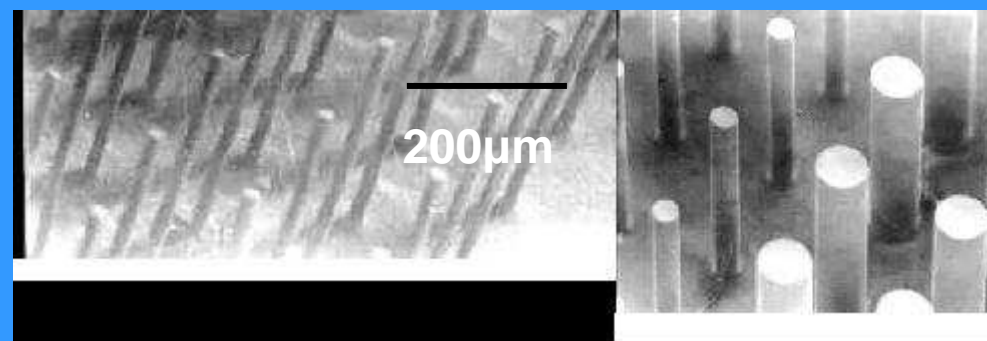
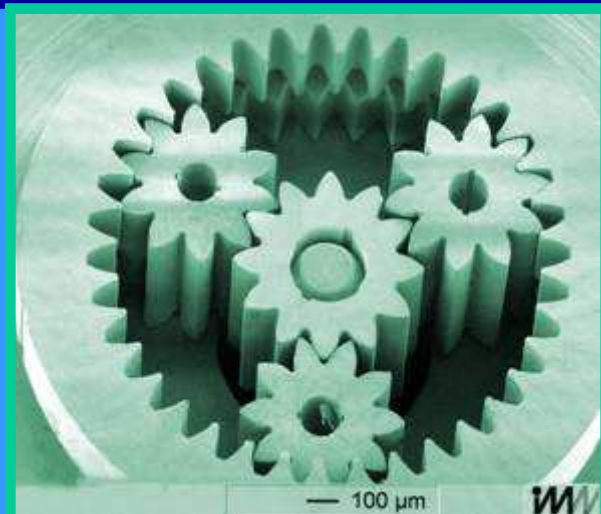
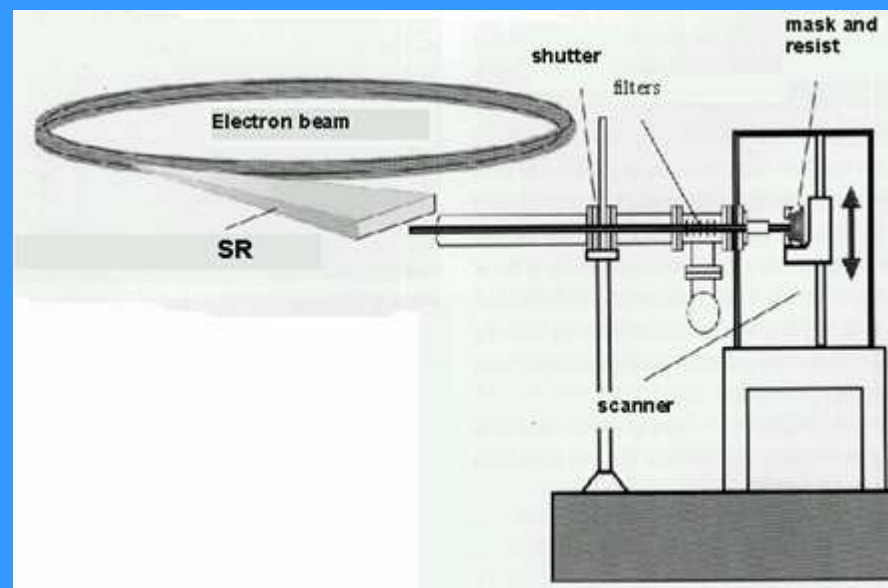




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## LIGA

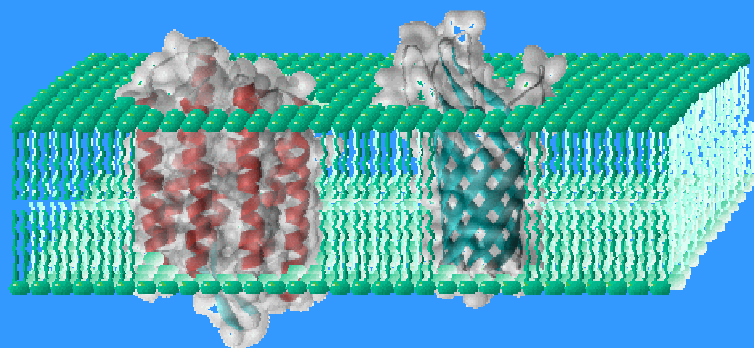
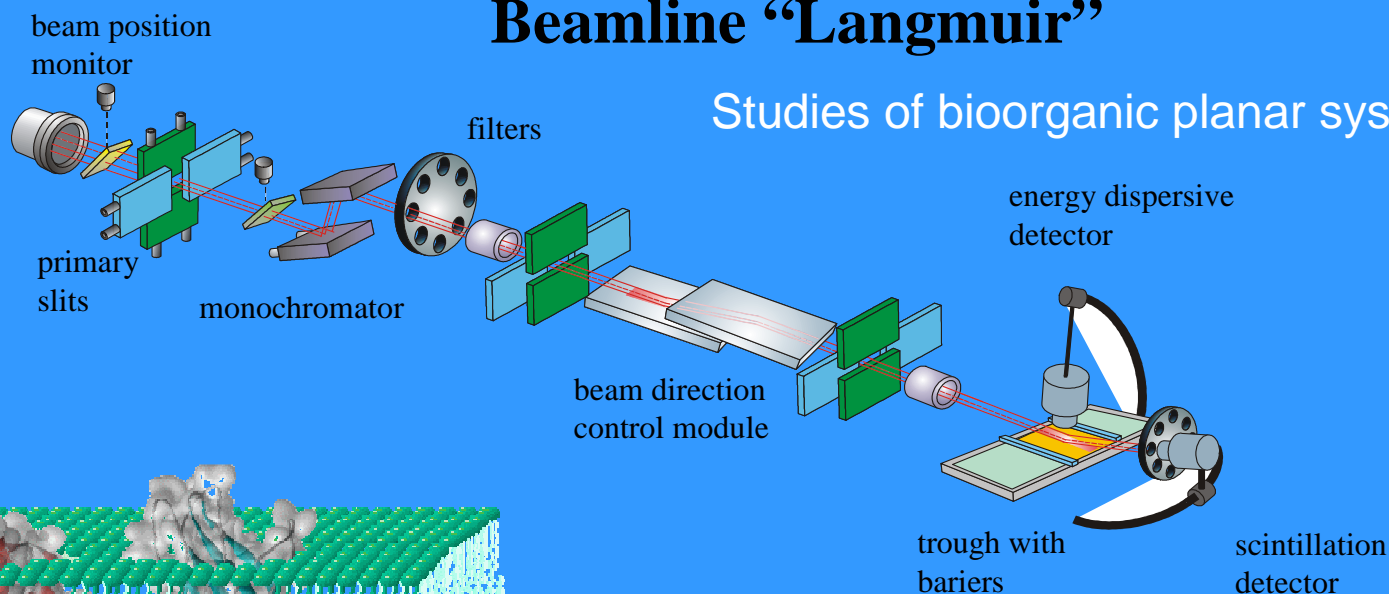




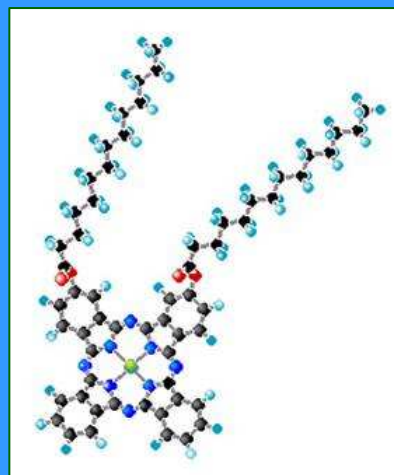
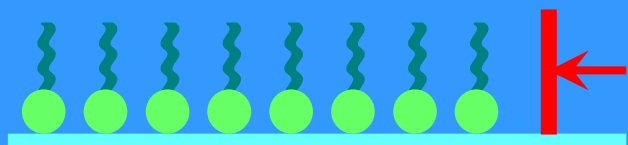
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## Beamline “Langmuir”

Studies of bioorganic planar systems.



Bio-membrane

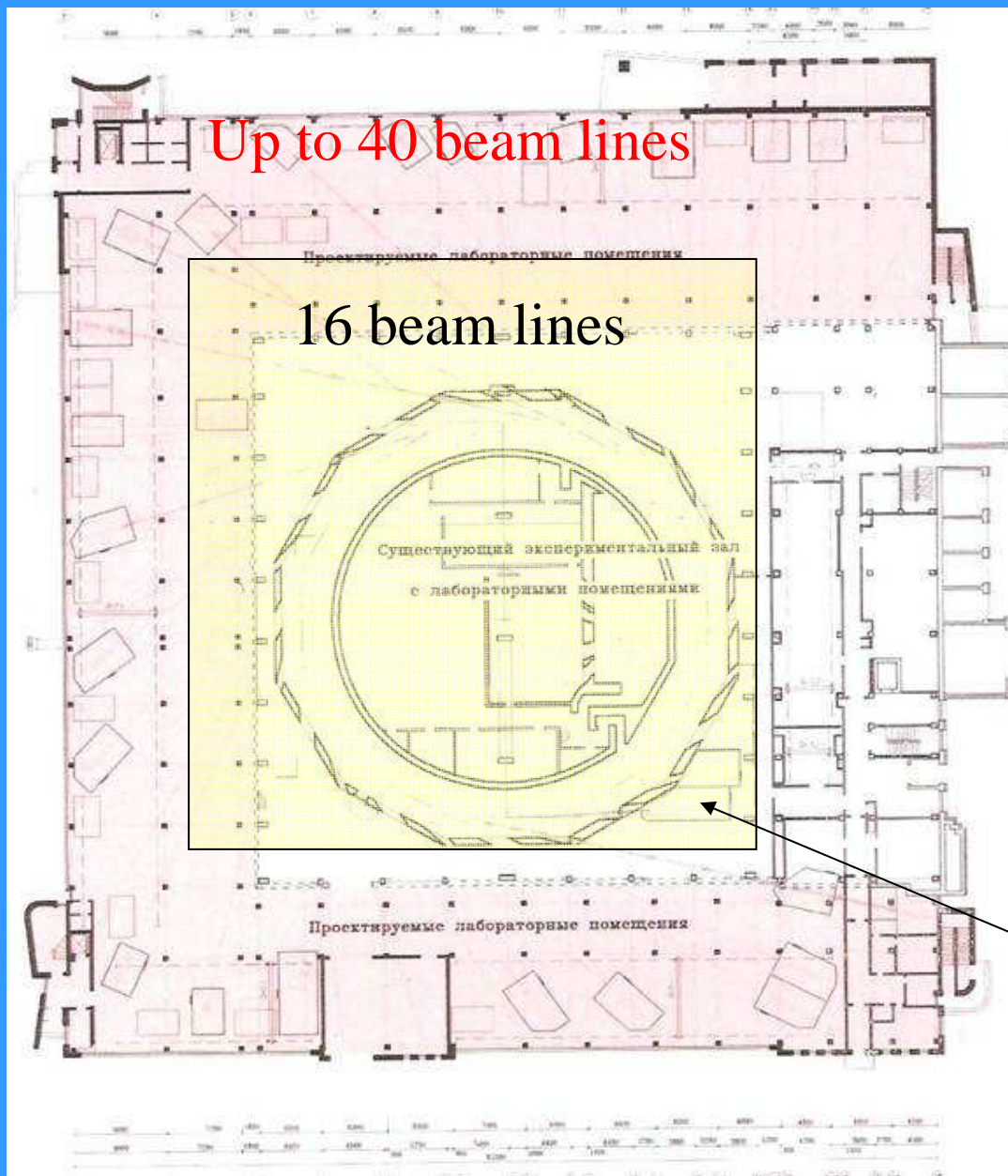






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## New Experimental Hall



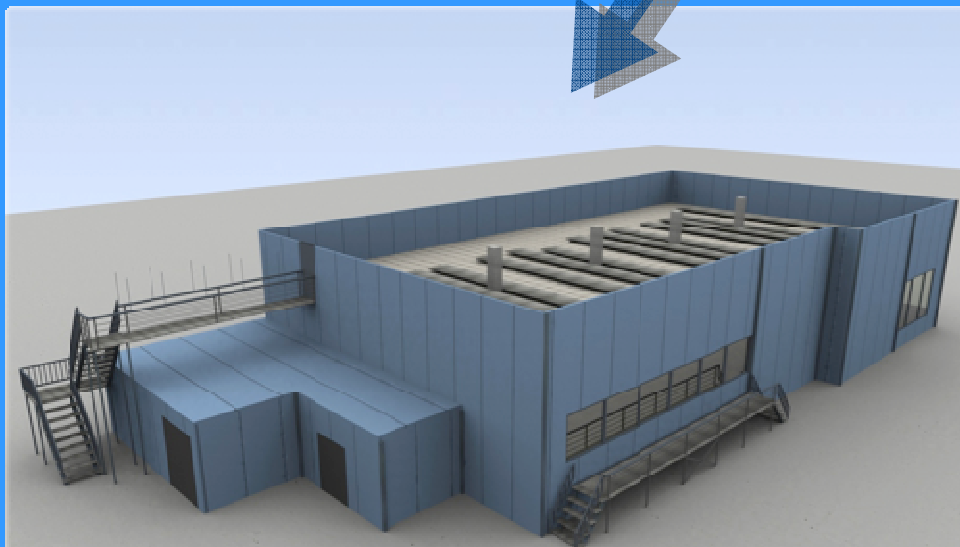
$S = 4\,850$  sq.m

$S = 950$  sq.m

Old experimental hall



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## Nanotechnology Facility on the NANOFAB platform





# KURCHATOV CENTER OF SYNCHROTRON RADIATION AND NANOTECHNOLOGIES

## Molecular Beam Epitaxy





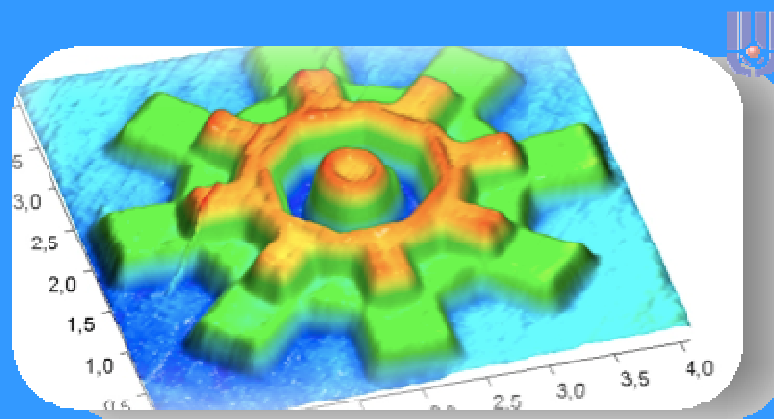
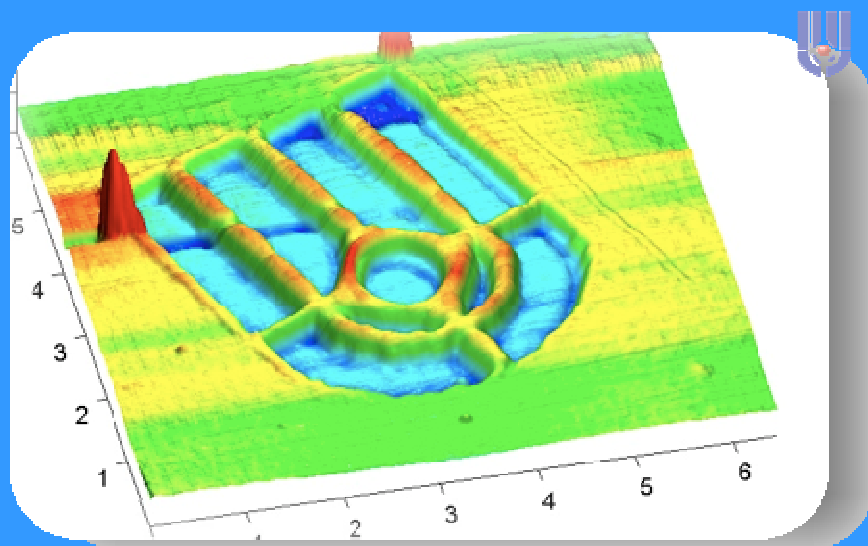
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## CVD SETUP





# KURCHATOV CENTER OF SYNCHROTRON RADIATION AND NANOTECHNOLOGIES





# **ELECTRON MICROSCOPY LAB**

## ***Instruments***

### **Scanning Electron Microscopy:**

*JEOL JSM-7401F.*

### **Dual Beam: Electron Probe+ Focus Ion Beam**

*FEI Quanta 200 3D, Helios*

### **Transmission Electron Microscopy + Electron Diffraction+ Microanalysis**

*FEI Tecnai G<sub>2</sub>30 TEM/STEM with EDXS*

*FEI Tecnai Spirit*

*Philips EM430 with precession ED system*

*TITAN 80-300 with C<sub>s</sub> probe corrector*

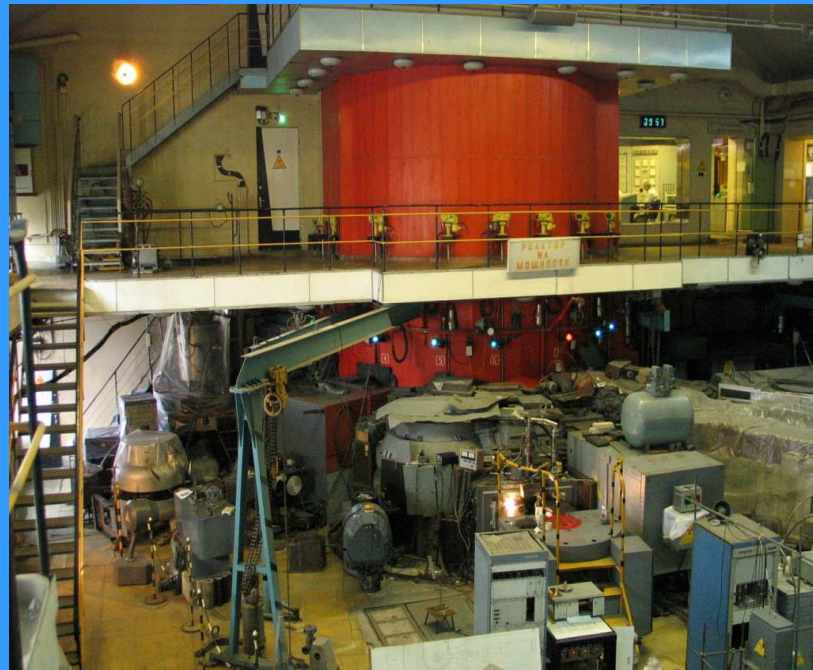
### **Sample prep equipment**



# RESEARCH NEUTRON SOURCE BASED ON NUCLEAR REACTOR IR-8



Difractometer MOND



Spectrometer ATOS



Difractometer DISK



Spectrometer STOIK





# RESEARCH NEUTRON SOURCE BASED ON NUCLEAR REACTOR IR-8

## **Main research fields**

- ◆ Surface analysis by ultra cold neutrons
- ◆ Neutron activation analysis by the use of thermal and fast neutrons
- ◆ Structure and phase transitions in crystals
- ◆ Phonon dispersion in crystals
- ◆ Magnetic and chemical inhomogeneities in condense matter
- ◆ Neutron optics

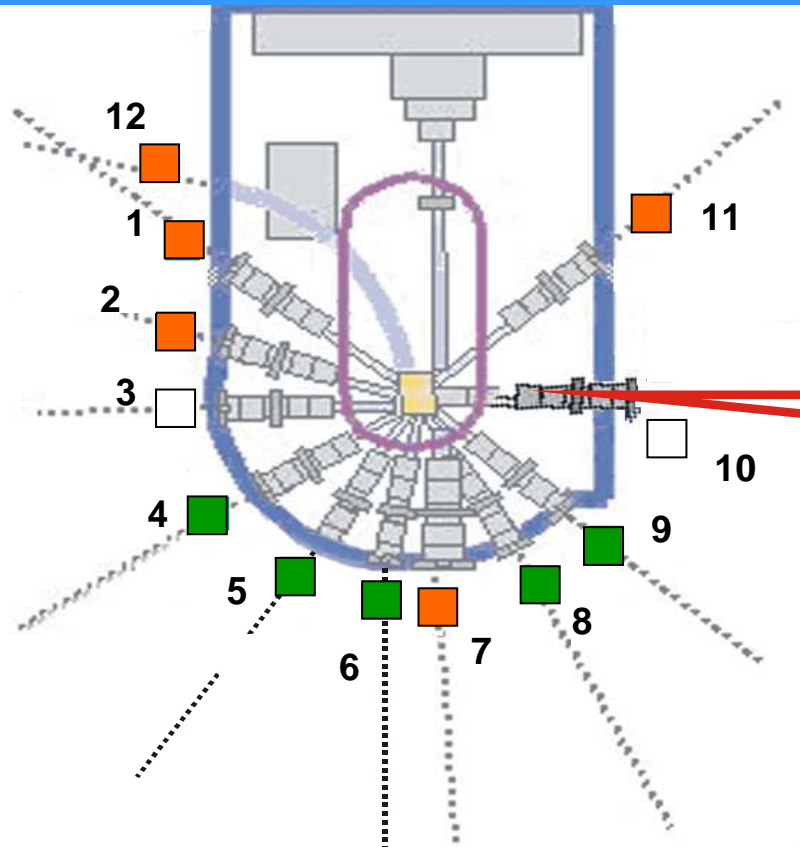
## **Main Objects**

- ◆ Magnetic nanosystems
- ◆ Hydrogen containing nanosystems
- ◆ Nuclear reactor materials
- ◆ Nanobiosystems



# RESEARCH NEUTRON SOURCE BASED ON NUCLEAR REACTOR IR-8

## Beam lines



- -Nuclear physics
- -Solid state physics
- New beam lines

- 1** – exited nuclei
- 2** – nuclear spectroscopy
- 3** – stress diffractometer
- 4** – diffraction on single crystals (MOND)
- 5** – diffraction on polycrystals (ATOS)
- 6** – diffraction at high pressure (DISK)
- 7** – capillary optics
- 8** – neutron radiography
- 9** – refraction and small-angle contrast (STOIK)
- 10** – new beam lines
- 11** – neutron physics
- 12** – ultracold neutrons



# NANOBIO-TECHNOLOGICAL CENTER

## Genomic lab





# NANOBIO-TECHNOLOGICAL CENTER

## Genomic lab





# NANOBIO-TECHNOLOGICAL CENTER

## Proteomic lab





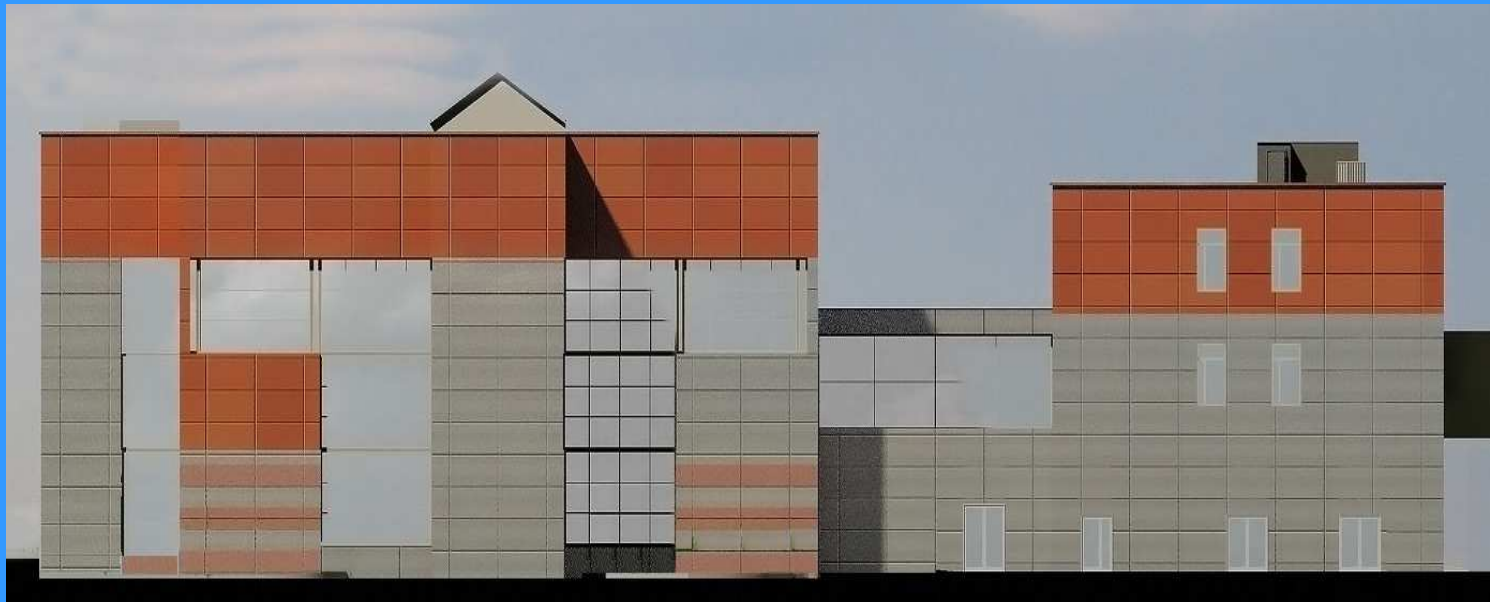
# NANOBIO-TECHNOLOGICAL CENTER

## Proteomic lab





# CENTER OF DATA DEVELOPMENT



Total area	11 270 m <sup>2</sup>
Performance	300 TFLOPS
Memory size	600 TB





# CENTER OF DATA DEVELOPMENT

## Functions

- ◆ Support of multiscale computational modeling in priority fields including nanotechnologies, material science, plasma physics, nuclear energy production.
- ◆ Support of information exchange system for scientific organizations-members of national nanotechnology net, GRID-portal for access to distributed resources.
- ◆ Support of effective exploitation and usage of unique research installations, net of user facilities centers for organizations carrying out research in the fields of nanotechnologies and nanomaterials.
- ◆ Storage, development and visualization of data, support of specialized data base for computer exchange of information for research and development in nanoindustry.



**Thank you for  
attention**

