Meeting of Consultative Scientific Council “Skolkovo”

*May 17-18, 2012* *Novosibirsk*

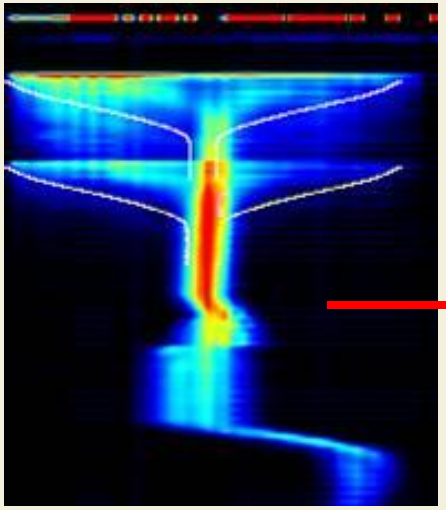
# SIBERIAN BRANCH OF RUSSIAN ACADEMY OF SCIENCES: STATUS, RESEARCH AND DEVELOPMENT

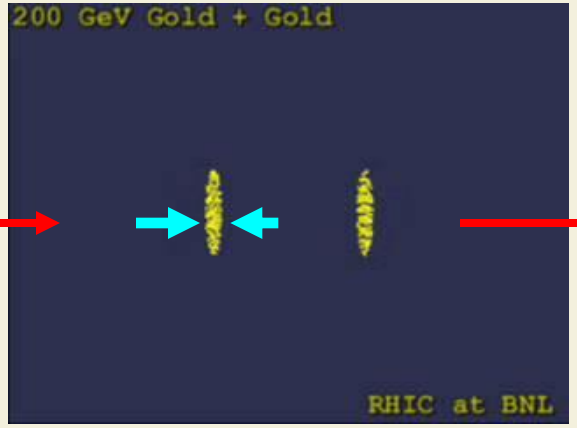
**Academician A.L. Aseev**
**Chair of Siberian Branch of RAS**

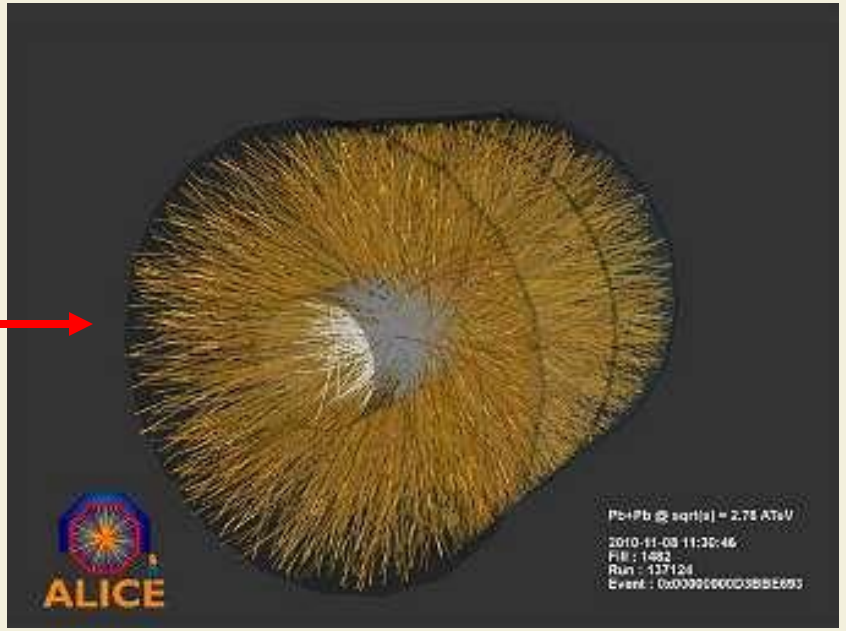
# SELECTED RESEARCH RESULTS AND PROJECTS

# Budker Institute of Nuclear Physics Siberian Branch of RAS

In November, 2010 at the Large Hadron Collider suppression of particle jets was detected for the first time while colliding heavy ions Pb*Pb with the world's highest ion beam energy. The key role in that successful experiment was played by the high voltage electron cooler designed and produced at Budker INP and installed at the low energy ion ring LEIR at CERN.





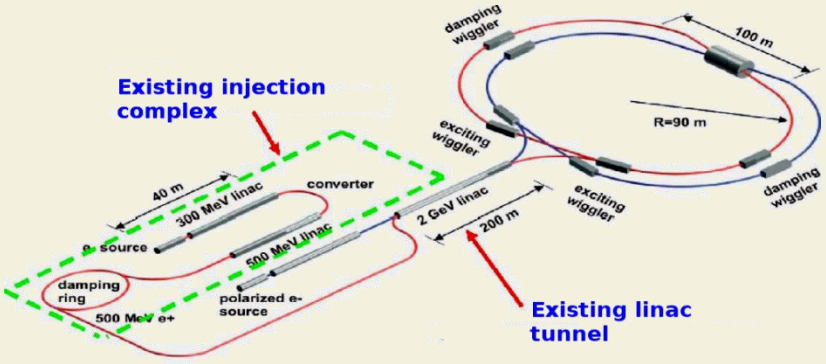

**At the profile monitor demonstrates that the electron cooler after first injection decreases the ion beam diameter and after second injection the beam size decreases again and intensity of ion beam becomes high (red color). After final cooling the beam accelerates and sends at next accelerator for using at LHC.**

**For central collision density of this fireball is close to density of initial stage Big Bun of our universe.**

**The decay of this superdense nuclear generated many hundreds particles that measured at detector ALICE**

Project of Budker Institute of Nuclear Physics Siberian Branch
of the Russian Academy of Science, Novosibirsk

# New electron - positron collider: c-τ fabric





Damping ring of the injection complex

Total budget of the project: 406 MEuro
Including: - required federal budget: 305 MEuro
- "off-budget" contribution: 101 MEuro

**The project will solve a whole number of problems in the fundamental physics:**

**- search of *CP*-violating effects in decays of charmed particles,**
**- search of "new physics" in rare or forbidden by the Standard Model decays of charmed particles,**
**- tests of the Standard Model in the decays of *τ*-leptons,**
**- search and study of the totally new forms of matter – glueballs and hybrids, etc.**

**Multifunctional and interdisciplinary performance of the project:**

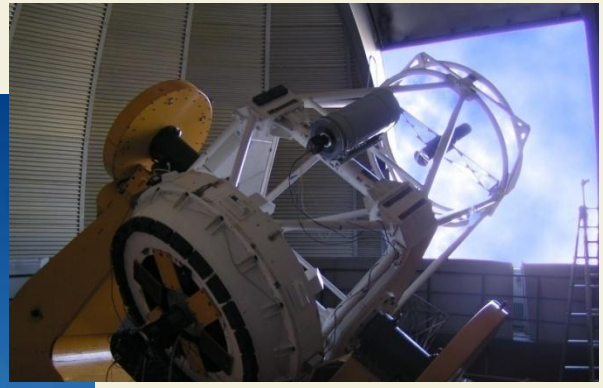
**- development of new technical and technological capabilities (accelerator, vacuum, superconductor technology, detection technique, etc.)**
**- e+e- collider is a high brighness source of synchrotron radiation for research in materials science, biotechnology, nanotechnology etc.**

**Current status of the project:**

**- The physical program is developed**
***- The detailed Conceptual Design report of the accelerator complex and the detector of the Super-c-τ-factory has been written***
***- A number of prototypes of accelerator key elements were designed and produced***
***- Designing of buildings, facilities and other infrastructure has begun***
***- The new injection complex for the future factory has been built and commissioned***
***- Memorandums of understanding with KEK (Japan), LNF/INFN (Italy) and John Adams Institute (UK) are signed***

# Creation of National Heliogeophysical Center
# Project of Institute of Solar and Terrestial Physics of SB RAS

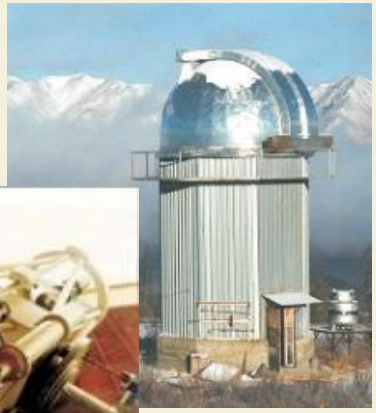
**AZT33-IR INFRARED TELESCOPE**



D=1,7 m, F=30 m
Velocity range 0,1"/s–5‘/s
Aperture ratio in Cassegrain focus 1:20

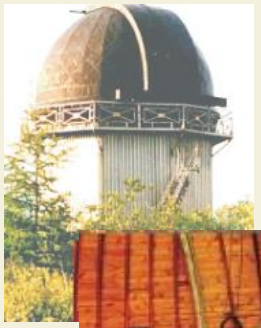
AZT33-IR equipment:
- IR-bolometer (8–14 μm);
- IR-camera (3,7–5,5 μm) with 256×256 el. photodetector;
- CCD-camera with 1024×1024 el. photodetector;
- IR-photometer (1–5 μm);
- visible photometer-polarimeter;
- vacuum station

**AZT-14A TELESCOPE**



D=0,5 m
V=0,25"/s–1,5º/s
λ=0,4–0,85 μm
1,5º×2,0º wide-angle camera,
$m_R$=15 (10 s)

**ZEISS-600 TELESCOPE**



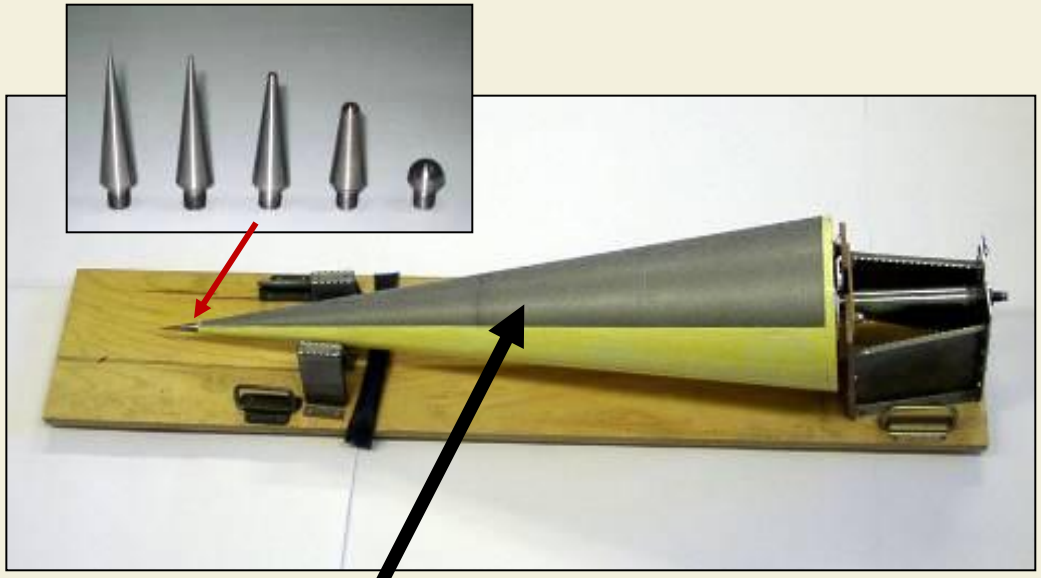
D=0,6 m
V=0,25"/s–0,5º/s
λ=0,3–1,1 μm
1040×1160 px CCD-camera
$m_R$=19 (3 min)

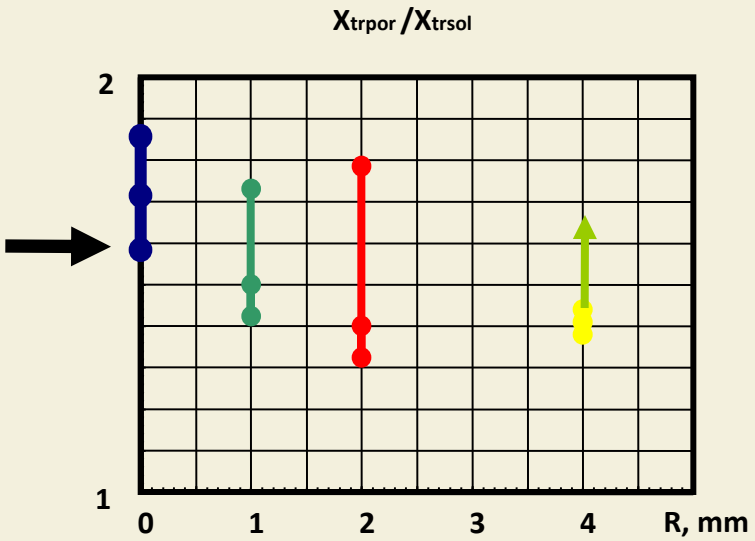
The telescope astrophysical complex serves to monitor space and observe space objects.

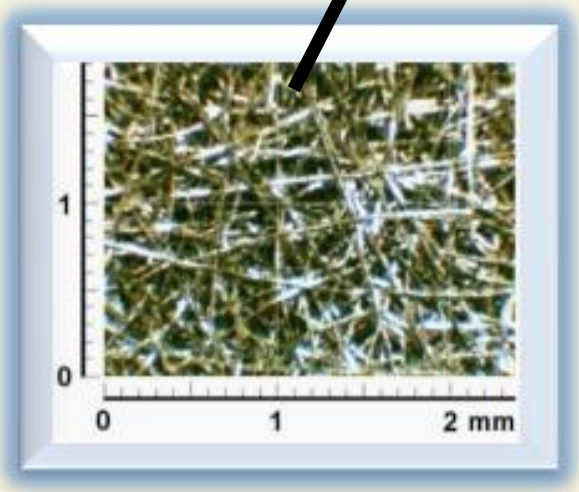
Providing optical information on high-apogee space objects. Obtaining special series of non-coordinate information on space vehicles in emergency situations.

- Measuring orbit parameters and reflective-radiative characteristics of space objects over 200 km altitudes in visible and IR spectra (0,3–25 μm).
- Remote monitoring thermal conditions of space vehicles with nuclear propulsion systems.
- Monitoring deployment and supplement for strategic groups of special purpose space vehicles.
- Measuring physical characteristics and orbital parameters of asteroids and comets approaching the Earth.

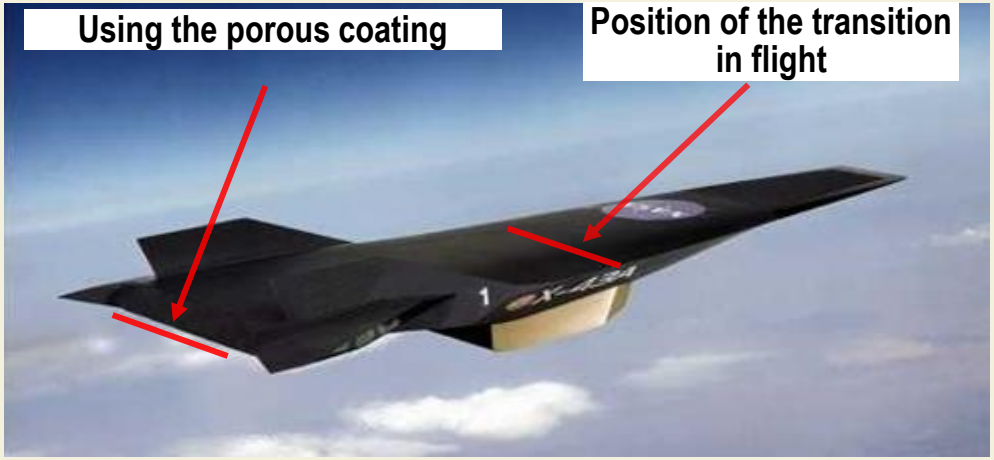
# The mechanisms of laminar flow stabilization at hypersonic speed are shown for the first time in the world






## Laminar-turbulent transition on the hypersonic aircraft



# High stable optical frequency standard on ultracold Mg atoms

A laser source at a wavelength of 457 nm with a radiation line width of ~1 KHz has been created at the Institute of Laser Physics SB RAS. With this source, spectroscopic investigations of ultracold (T~ 1mK) Mg atoms localized in a magnetooptical trap were made. First experiments on measurement of the $^1S_0 \rightarrow {}^3P_1$ transition frequency of the Mg atom were performed with a femtosecond optical clock. The measured transition frequency $\nu_{meas}$= 655659923834,1(5) KHz. It was determined that the measurement accuracy can be increased by 2-3 orders of magnitude. The results obtained are an important step in the creation of new-generation optical frequency standards with a stability at a level of $10^{-17}$ to improve the GLONASS system.

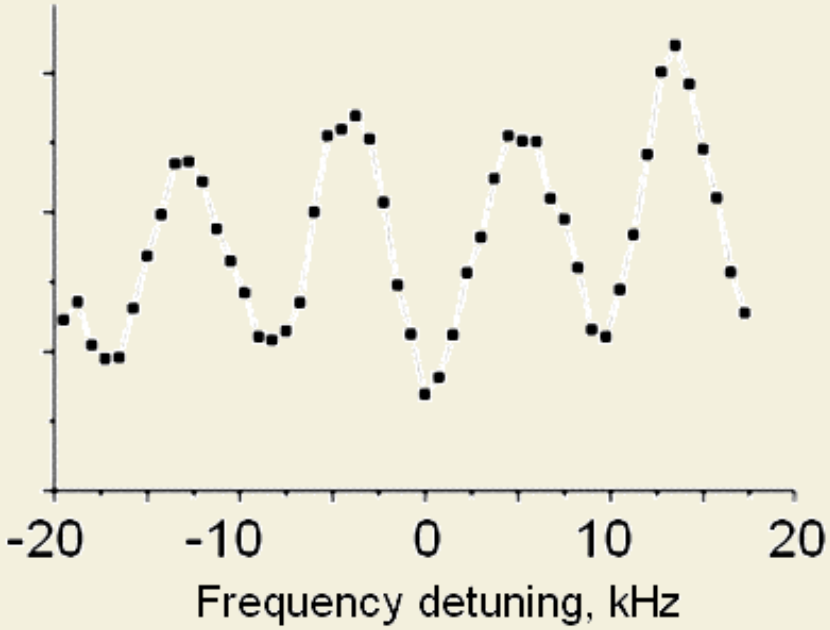



Fig.1. Ramsey resonances in time-separated laser fields at the interaction with Mg atoms cooled and localized in a magnetooptical trap.

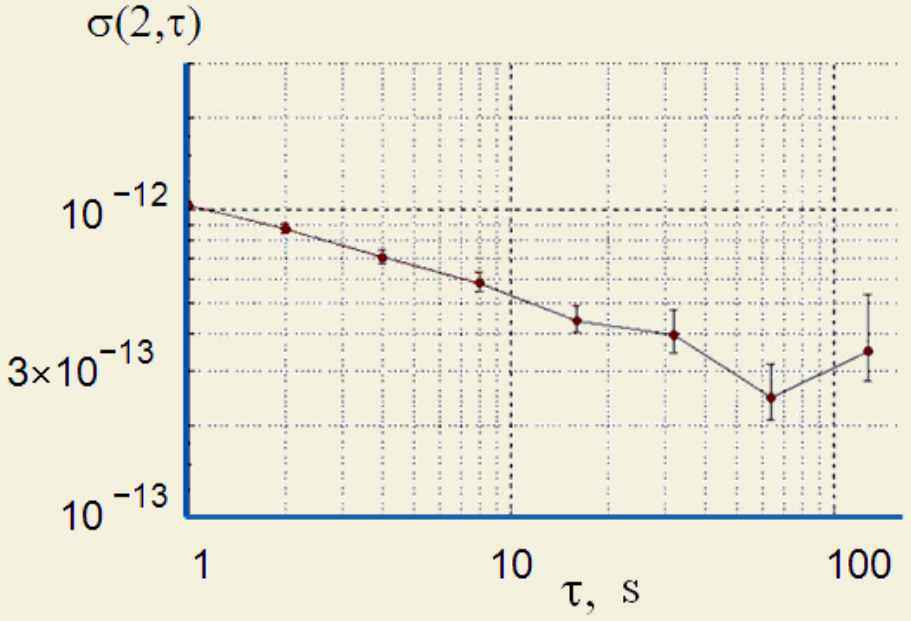
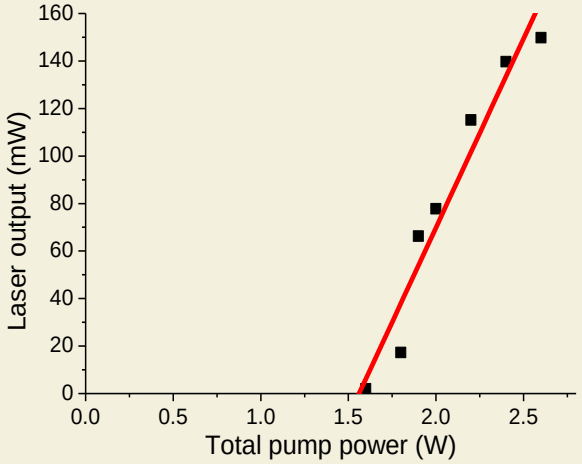
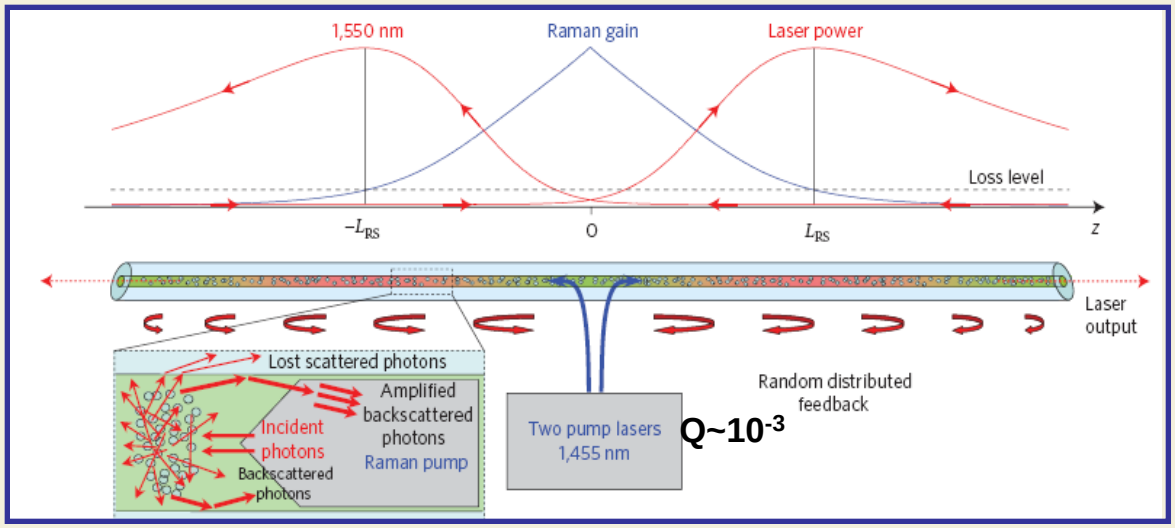



Fig.2. Allan parameter for measurement of $^1S_0$ - $^3P_1$ transition frequency of Mg atoms.

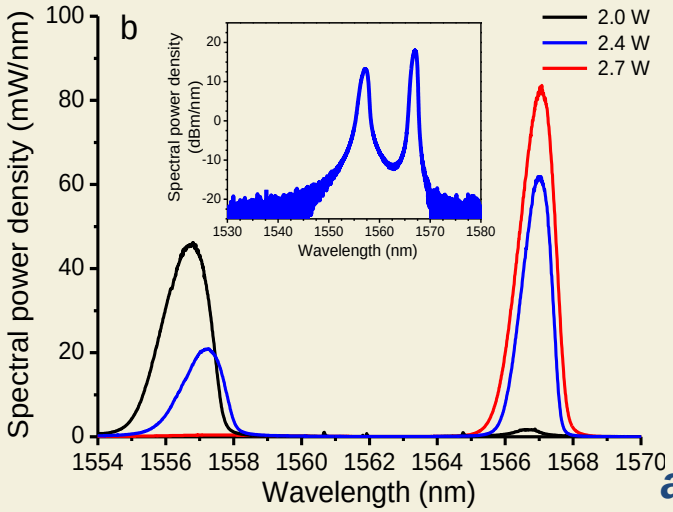
# Random distributed feedback fiber laser

## Output power:




## Output spectrum:




**Fiber laser without cavity (no mirrors)**

**II**

**1-dimensional random laser:**

***Gain is due to Raman scattering***

***Feedback is due to Rayleigh Scattering***

- *High efficiency (>30%)*
- *Narrow «modeless» spectrum (FWHM~1,5 nm)*
- *Tunability without selective/tuning elements*
- *No cavity length limit*

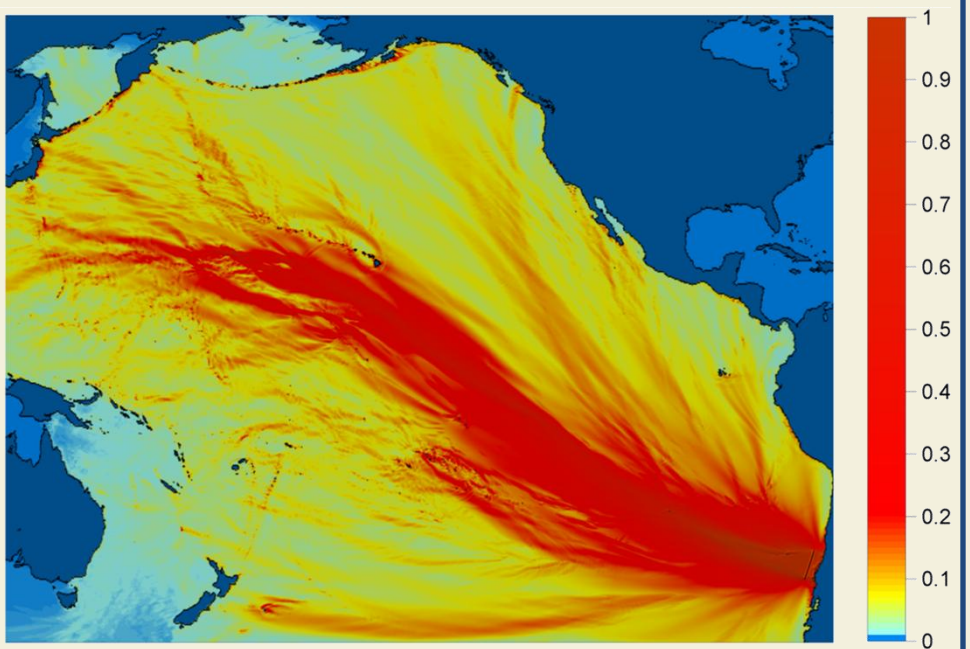
***appliications in long-haul communications and sensing***

*S.K. Turitsyn, S.A. Babin, A.E. El-Taher, P. Harper, D.V. Churkin, S.I. Kablukov, J.D. Ania-Castañón, V. Karalekas, E.V. Podivilov. "Random distributed feedback fibre laser",* ***Nature Photonics****, 2010, v.4, N4, p.231-235.*

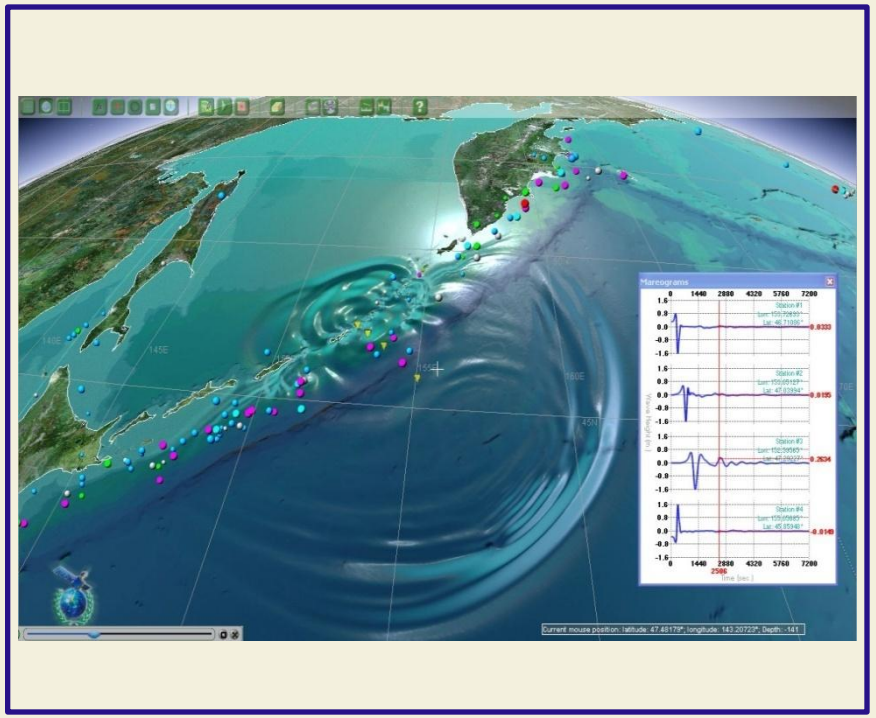
The Institute of Computational Mathematics and Mathematical Geophysics SB RAS

# EXPERT SYSTEM FOR TSUNAMI RISK ASSESSMENT

The results of the modeling of tsunami in the Pacific triggered by the powerful underwater earthquake with the 8.0 magnitude that took place near Chili on February 27, 2010.



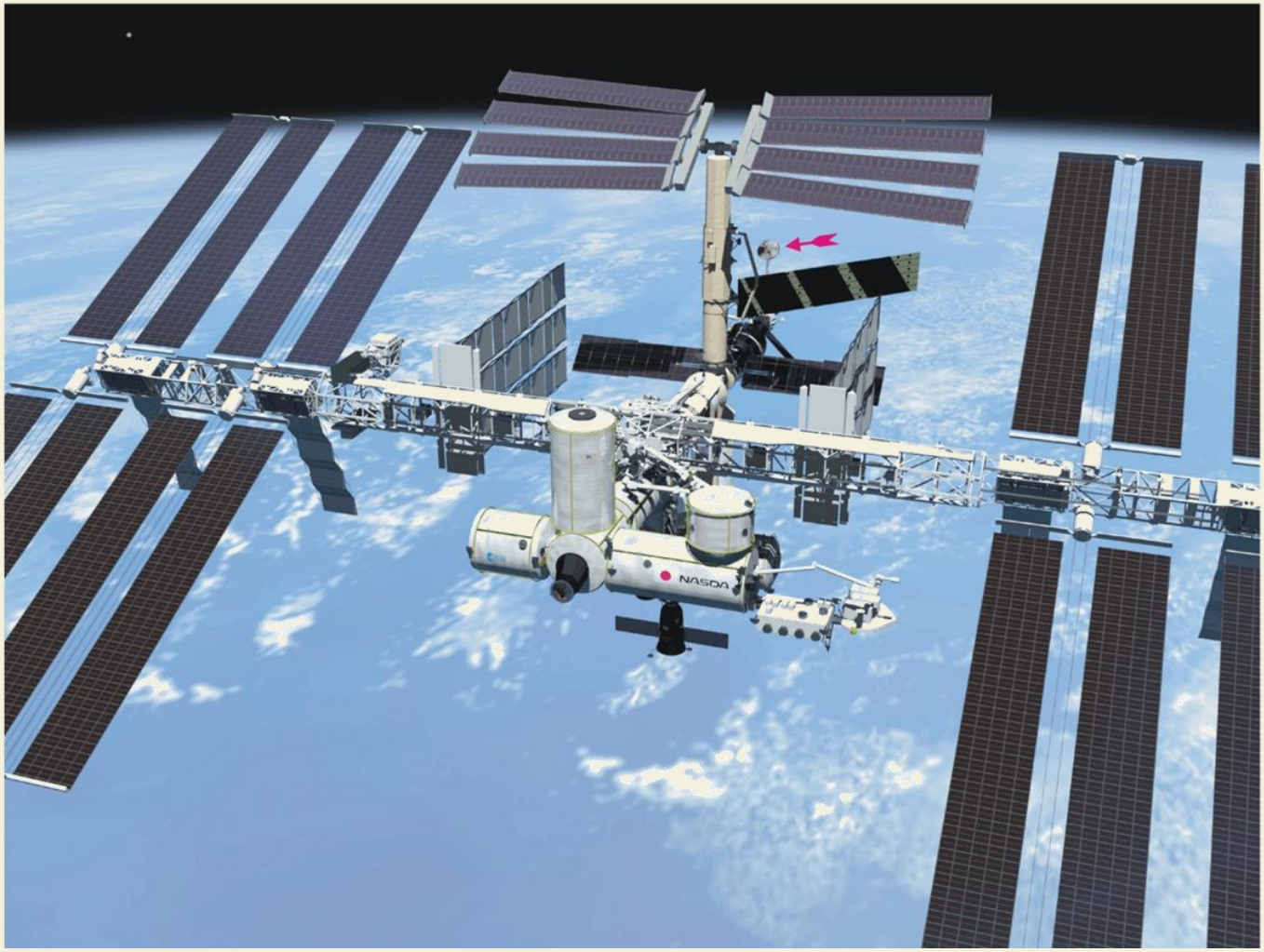

Numerical simulation
of the Simushir Tsunami (January 13, 2007)



A specialised cartographic shell ITRIS (Integrated Tsunami Research and Information System) is created on the base of principles of GIS technology. It includes software components and computational algorithms for tsunami and earthquake simulation as well as information resources (satellite images, numerical models of relief, materials of remote sensing, historical catalogues, observed data and results of simulation).

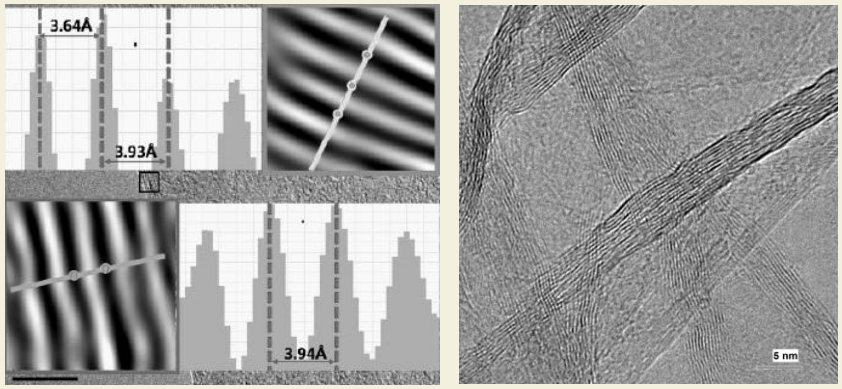
# MBE space research project “Shield”

**In cooperation with Russian Aerospace Agency and Houston University (USA)**



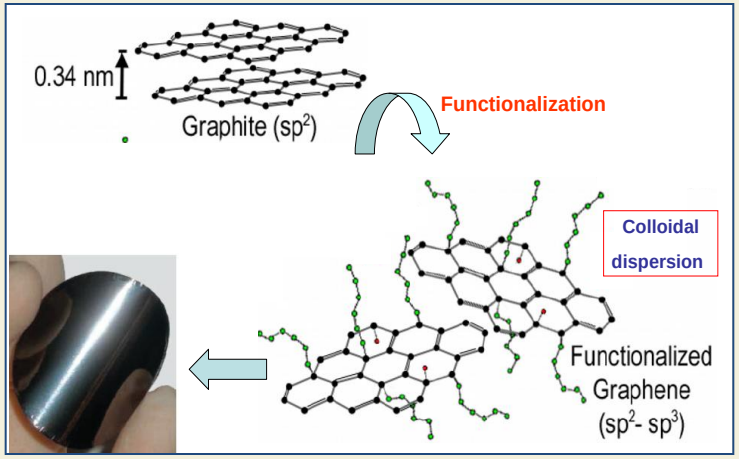
# PREPARATION AND PROPERTIES OF GRAPHENE – NOVEL CARBON MATERIAL

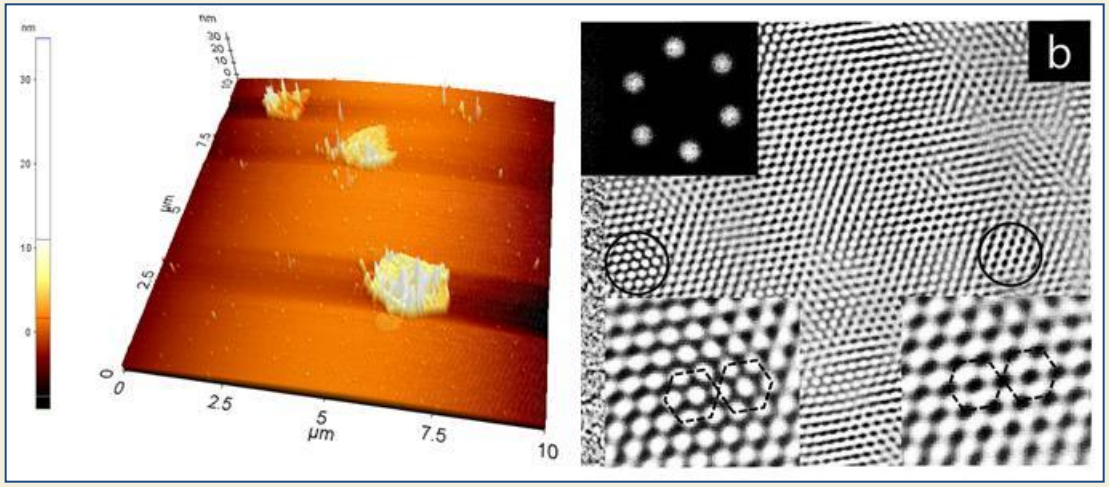
**Electron microscopic images of highly exfoliated nanosized graphite**




**High electron mobility at room temperature, some quantum effects (quantum Hall effect, ballistic transport and others), high mechanical breaking strength, excellent thermal conductivity, transparency – all these remarkable properties determine the potential of graphene for development of various important devices: field-effect transistors of new generation, transparent electrodes for LCD, solar cells, ultracapacitors, biodevices and other applications.**

**Preparation of graphene through chemical functionalization and colloidal dispersion**

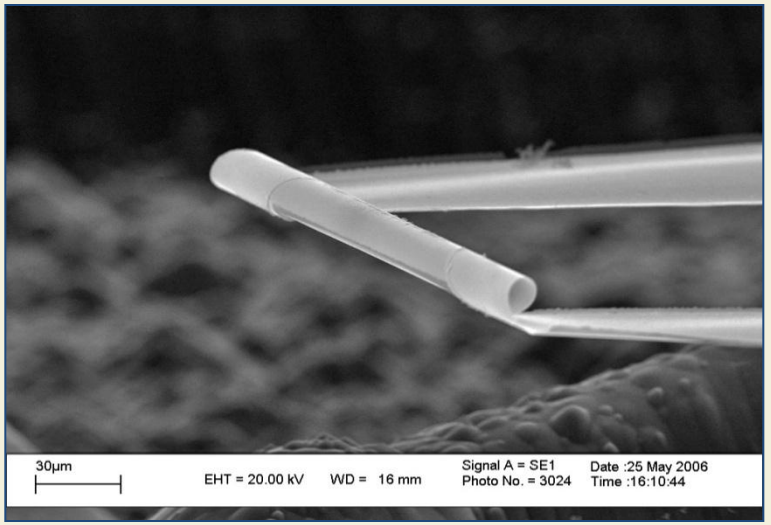



**AFM data of graphene-DMF dispersion (left) and electron microscopic images of graphene film (right)**

Nikolaev Institute of Inorganic Chemistry, Siberian Branch of RAS

# FABRICATION OF 3D NANOSTRUCTURES USING HIGH-PRECISION STAMP LITHOGRAPHY INSTALLATION UNDER SUPERPURE CONDITIONS (CLEAN ROOM, 1-10 CLASS)




**Line width — 10 nm, wafer diameter — 150 mm**

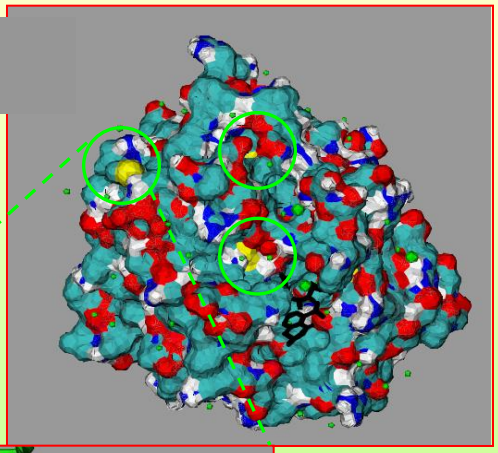
# Functional proteomics

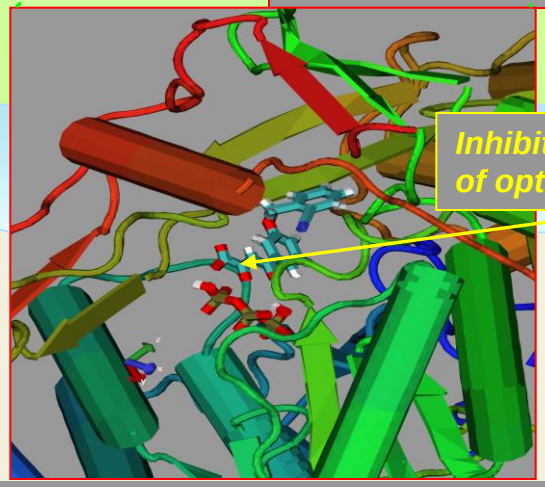
## Design of inhibitors of specific proteins

*Institute of Chemical Biology and Fundamental Medicine*

### *Design of inhibitors of RNA polymerase of hepatitis C virus*

*Potential sites of inhibitor binding*

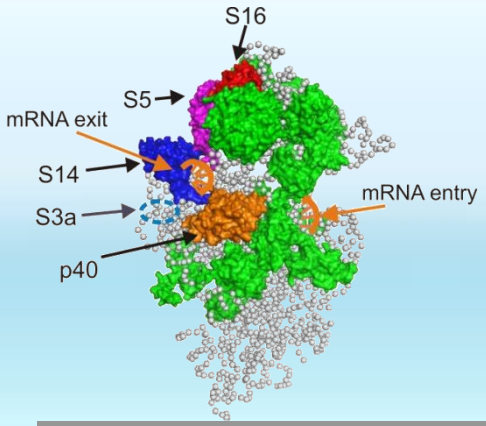




*Inhibitor in the site of optimal binding*

*This accelerates searching for new pharmaceuticals*

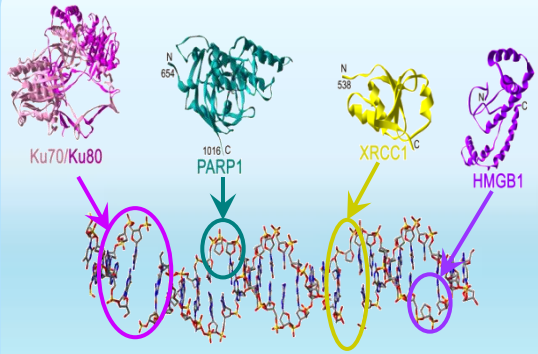
## Studying structures of complicated functional protein assemblies




*The structure of the human ribosome has been determined and arrangement of binding site for the IRES element of hepatitis C viral RNA has been established*

*It is necessary for elaboration of novel antivirus drugs*

## Proteomic analysis of DNA repair systems



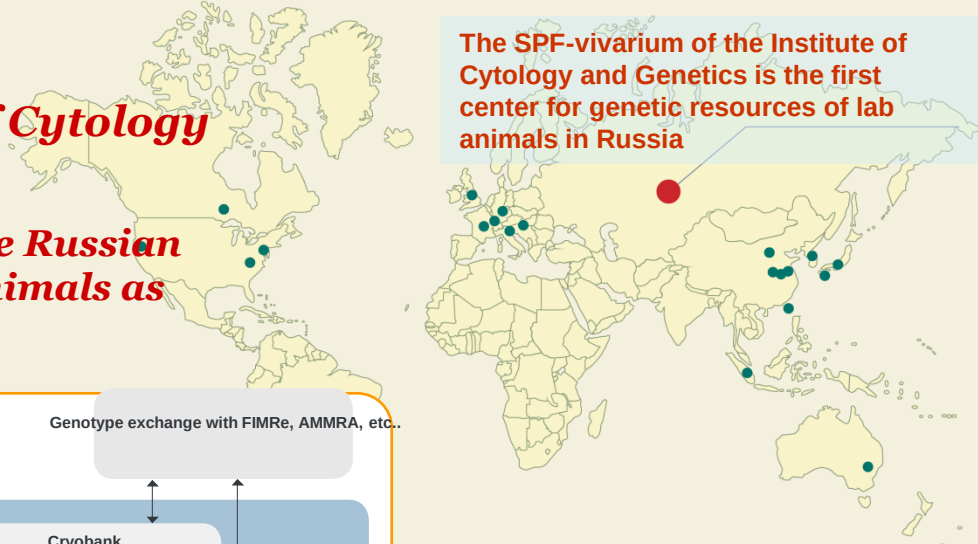

*New proteins controlling the efficiency of DNA repair functioning in human cells have been identified*

*It is necessary for elaboration of molecular diagnostics and anticancer treatment*

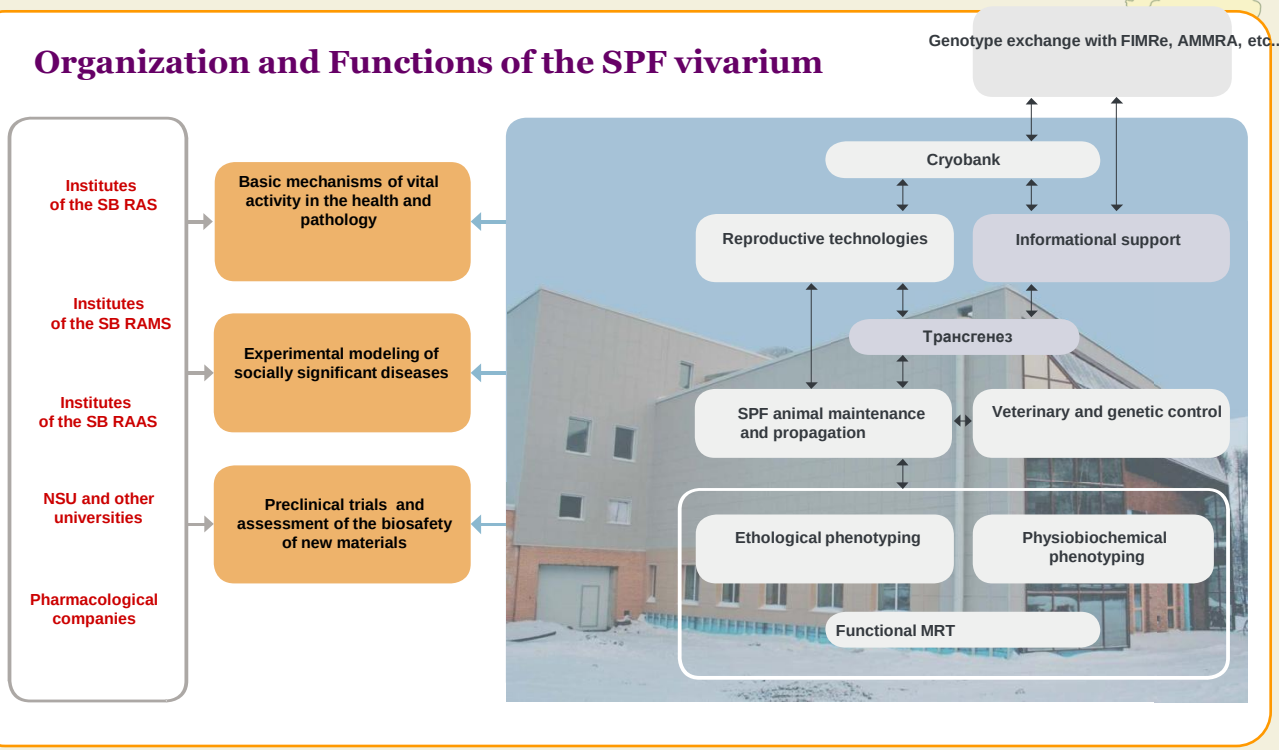
# *The SPF vivarium of the Institute of Cytology and Genetics is in operation*

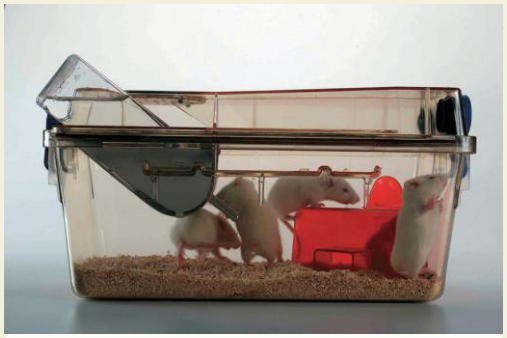
## *Core facility of the Siberian Branch of the Russian Academy of Sciences in the field of lab animals as genetic models*

**The SPF-vivarium of the Institute of Cytology and Genetics is the first center for genetic resources of lab animals in Russia**



## Organization and Functions of the SPF vivarium

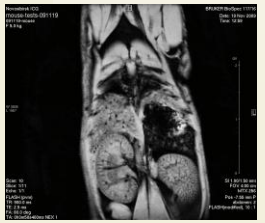


MRT equipment

Reproductive technologies

Cage keeping



MRT image of a healthy male mouse

# Institute of Archaeology and Ethnography of SB RAS

***Nature 464**, 894-897, 8 April 2010*

**The complete mitochondrial DNA genome of an unknown hominin from southern Siberia**

Johannes Krause[1], Qiaomei Fu[1], Jeffrey M. Good[2], Bence Viola[1,3], Michael V. Shunkov[4], Anatoli P. Derevianko[4] & Svante Pääbo[1]

1. Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany
2. Division of Biological Sciences, University of Montana, Missoula, USA
3. Department of Anthropology, University of Vienna, Austria
4. Institute of Archaeology and Ethnography, Siberian Branch of RAS, Novosibirsk, Russia

***Nature 468**, 1053-1060 , 23 December 2010*

**Genetic history of an archaic hominin group from Denisova Cave in Siberia**

**Joint research conducted at the Institute of Archaeology and Ethnography SB RAS and at the Max Planck Institute for Evolutionary Anthropology in Leipzig has led to a discovery of a hitherto unknown human species, tentatively designated *Homo altaiensis*. The mtDNA extracted from the hand phalanx of a hominid from an early Upper Paleolithic layer of Denisova Cave, the Altai (40–30 thousand years ago), reveals substantial differences both from modern human DNA and from that of *Homo neanderthalensis*.**

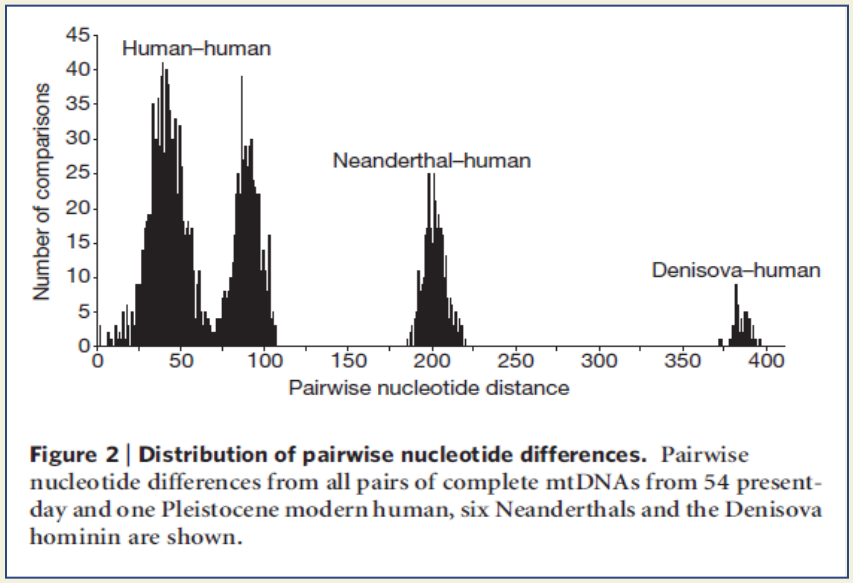



**Figure 2 | Distribution of pairwise nucleotide differences.** Pairwise nucleotide differences from all pairs of complete mtDNAs from 54 present-day and one Pleistocene modern human, six Neanderthals and the Denisova hominin are shown.