The International Conference "Nonlinear Optics: East-West Reunion"
September 21 - 23, 2011,

Suzdal, Russia

ISTC: 17 Years of Contribution to Bridging East and West in Nonlinear Optics

Dr. Yuri Malakhov

International Science and Technology Center, ISTC, Moscow

What is ISTC?

- *An intergovernmental nonproliferation organization*
- *'Nonproliferation through science cooperation'*

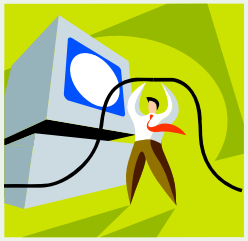
What are ISTC core objectives:

- ***Redirect*** **former WMD scientists of Commonwealth of Independent States (CIS)**
- **Reinforce the *transition to the market* economy**
- **Help *integrate former WMD scientists* into the global scientific community**
- **Contribute to *solving* national/global science & technology *problems***
- **Support basic and applied *research***

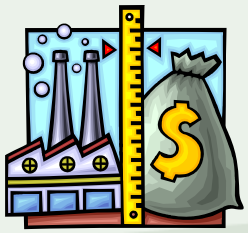
What does ISTC do?

ISTC funds and manages various science-related activities

- **Science projects**
- **Workshops/conferences**
- **Communications support**
- **Travel support**
- **Commercialization support**



Operation mode of ISTC - Legal, audited, effective, and transparent mechanism



Where ISTC Projects are Located?

Where does the funding come from?

- **Funding Parties**
  - Canada, European Union, Japan, United States, Republic of Korea
- **Funding Partners**

  Governmental, e.g.:
  - Several United States Departments and Agencies, e.g. Agriculture, Defense, Energy, Environmental Protection, Health and Human Services
  - EuropeAid

  Private Companies, *e.g.:*

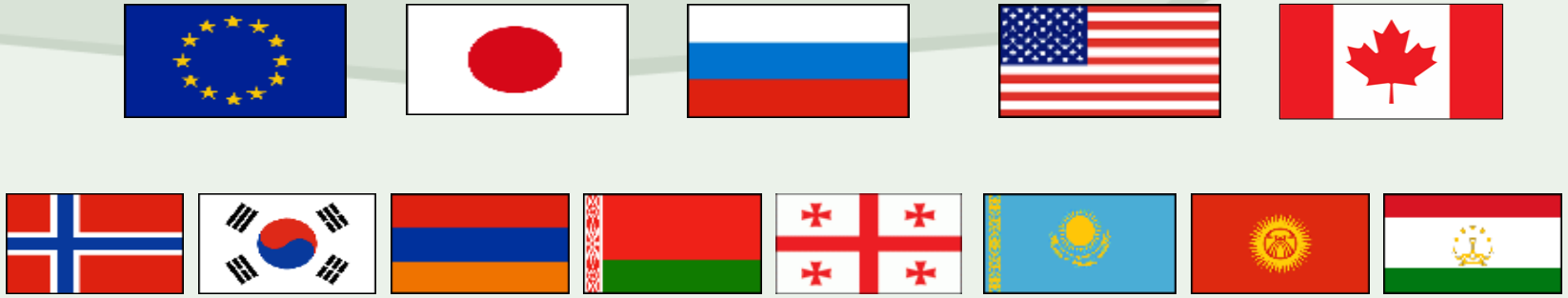
  - *Boeing, Airbus, Bayer, 3M, General Atomic, Mitsubishi*

Boeing

Mitsubishi

Over 400 Partners

History of ISTC



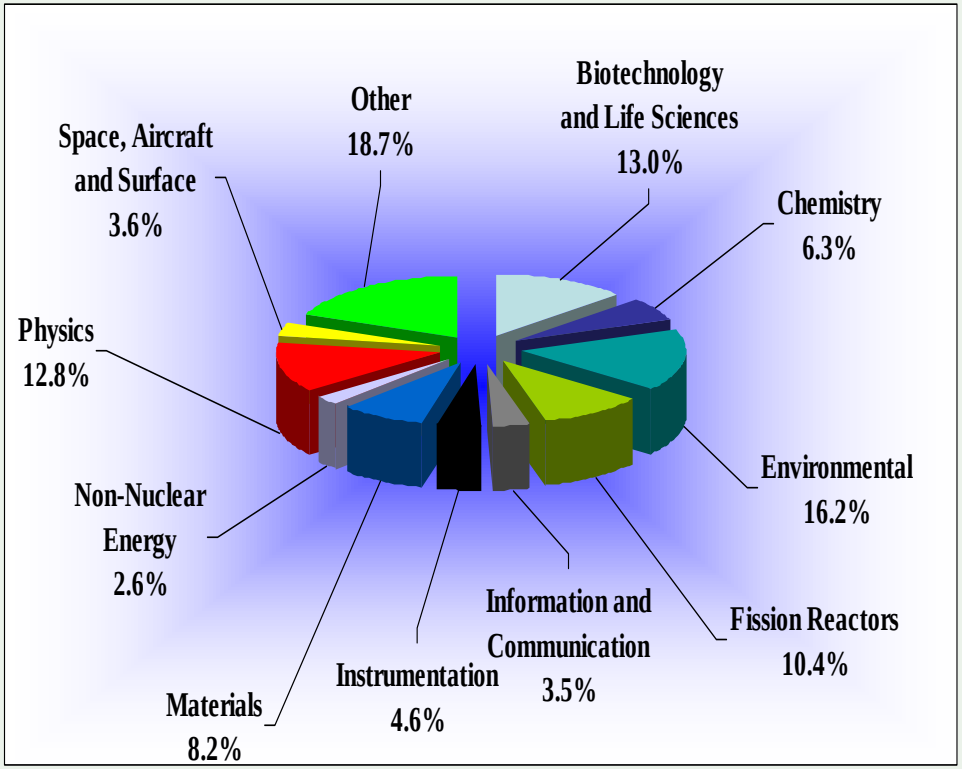
- Founded in 1992 by the governments of the EU, Japan, USA and Russia; operations began in 1994; Later, Norway, S. Korea and in 2004, Canada joined as Funding Parties
- Comprised of 39 nations, with the status of a diplomatic mission
- Many organizations (governmental and private) have become Funding Partners
- Headquarters in Moscow with Branch Offices in Armenia, Belarus, Georgia, Kazakhstan, Kyrgyz Republic, and Tajikistan

ISTC - 17 Years of Operation

- Network of over *900* R&D Institutes and research centers in Russia, Georgia and CIS
- Over *70,000* scientists/experts working with ISTC projects and benefiting from other ISTC programs
- More than 2700 funded projects to the value of *858 M$* support
- Thousands of scientists benefiting from mobility program
- Hundreds of conferences, seminars, workshops and working meetings supported by ISTC

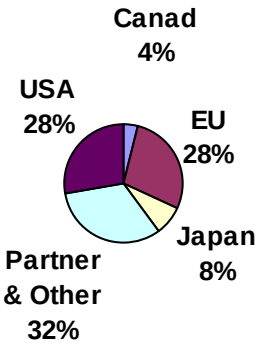
ISTC Core Activity: R&D Projects

Technological Areas of the Projects



Total R&D funds 858 M$

Funding Parties shares



Evolution of ISTC mission

Initial mission:

- "stop-gap" measure to gainfully employ former weapons scientists

  BRAIN-STAY – NOT BRAIN-DRAIN!
- forum for international community to engage CIS countries on nonproliferation and science issues

Ten years later:

- catalyst for innovation and technology development
- integration of CIS scientists into global initiatives
- science that is truly "in demand"
- greater emphasis on sustainability

ISTC : New Modes of Operation

- Start Up Activities/Projects in the Large Scale Research Infrastructures program

- International Science Laboratory program

  Long term collaboration with ISTC partner with financial means

- Targeted Initiatives – a package of ISTC instruments

  ISTC Parties and Partners contribute voluntarily to the TI through funds allocation for R&D tasks presented by the Secretariat in a form of a Work Plan

CERN - ISTC Projects

- From 1995: about 45 projects, some of them with multiple extensions, among them:
  - Regular projects
  - Regular projects with CERN co-funding
  - 7 Partner Projects
- The majority of the projects are very successfully completed;

  9 are continuing;

  Total projects volume 31 M$US

  of which ISTC contributed 12 M$US

  and CERN 19 M$US
- One particular ISTC project generated a 36M$ commercial contract for single crystal delivery

ISTC funded devices in key multibillion CERN detectors! Example of ATLAS

Bus-bars/ ISTC

CSC frames / ISTC

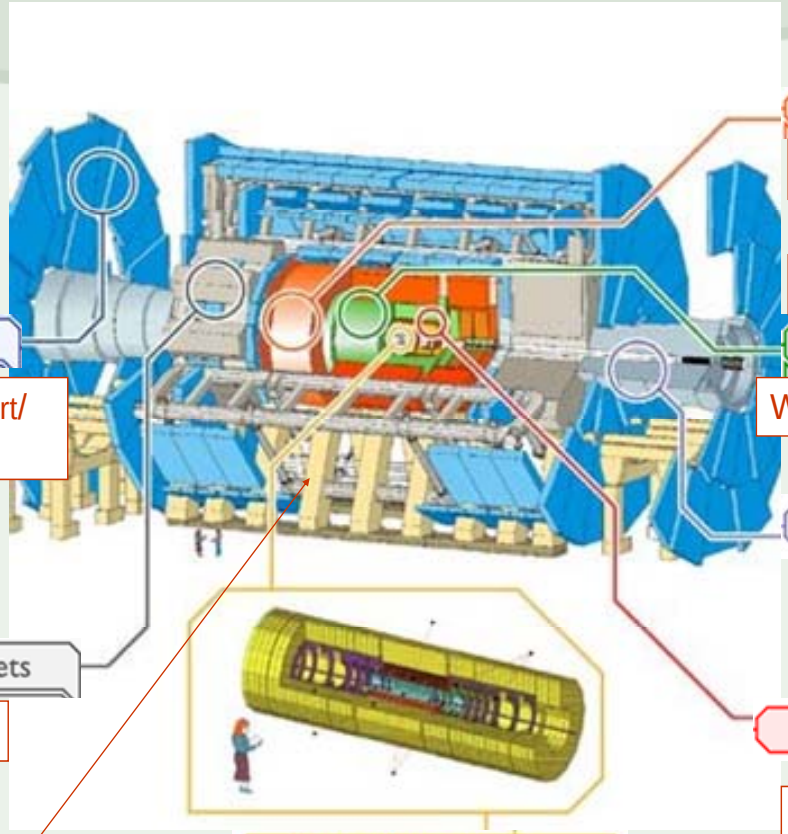
Muon Chambers

Muon Wheel support/ ISTC

Toroid Magnets

Ti rods/ISTC

Feet&Rails/ISTC



Tiles/ ISTC

Absorber/ ISTC

W-rods /ISTC

10.1 MCHF
6.6 MCHF (CERN)
3.5 MCHF (ISTC)

TRT/ ISTC

Spines / ISTC

Moulds / ISTC

B.I. Stepanov Institute of Physics NAS Belarus

International Science and Technology Center

Fraunhofer Institut Zerstörungsfreie Prüfverfahren

ISTC ISL-LOD was established in 2003 and consists of two branches:

the first branch is a part of the Fraunhofer Institute for Nondestructive Testing (Saarbrucken and Dresden, Germany);

the second branch is established as the laboratory for Fundamental and Applied Research of the B.I. Stepanov Institute of Physics of NAS of Belarus (Minsk, Belarus).

Targeted Initiative

- Fuel Cells (almost completed)
- Law Enforcement
- Drug Design
- S&T Biological Treats
- Probiotics
- High Energy Physics
- Ultra-High Intensity Light Science and Technologies (under development)
- Verification and Safeguards (under development)

ISTC Targeted Initiative “Ultra-High Intensity Light Science and Technologies”

Proposed at the international conference, dedicated to matters of cooperation between the leading institutions of Russia and representatives of large-scale European projects ELI/HiPER/PETAL (ISTC, Moscow, November 24-25, 2008).

The aim of this TI is to develop an international partnership in the domain of high power and high intensity lasers

ISTC workshops and seminars

The 2d Franco-Russian ISTC Workshop on the physics with PETAL and the diagnostic development, March 9 - 11, 2009, Le Barp, France

Outputs of the workshop:

ideas for future collaborative projects, implying further experiments, development of diagnostic and large optics equipment on the PETAL installation

HiPER – Russian Federation 2d Workshop
March 15 – 16, 2010, Cosener's House, Abingdon, UK

Outputs of the workshop:

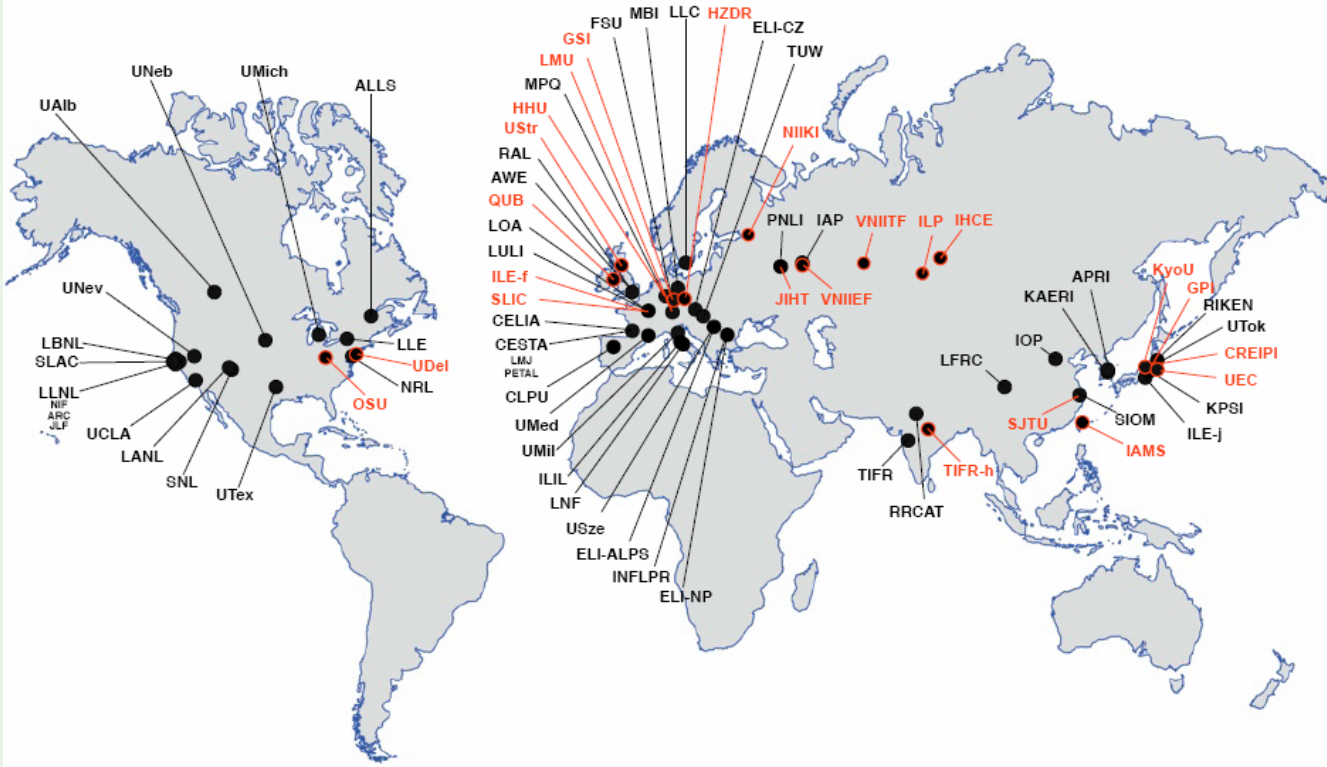
identification of technical areas with a high degree of overlap between the capabilities of Russian institutions and the requirements of the HiPER project
(an initial list of priorities for detailed integration into the HiPER plan for the next phase)

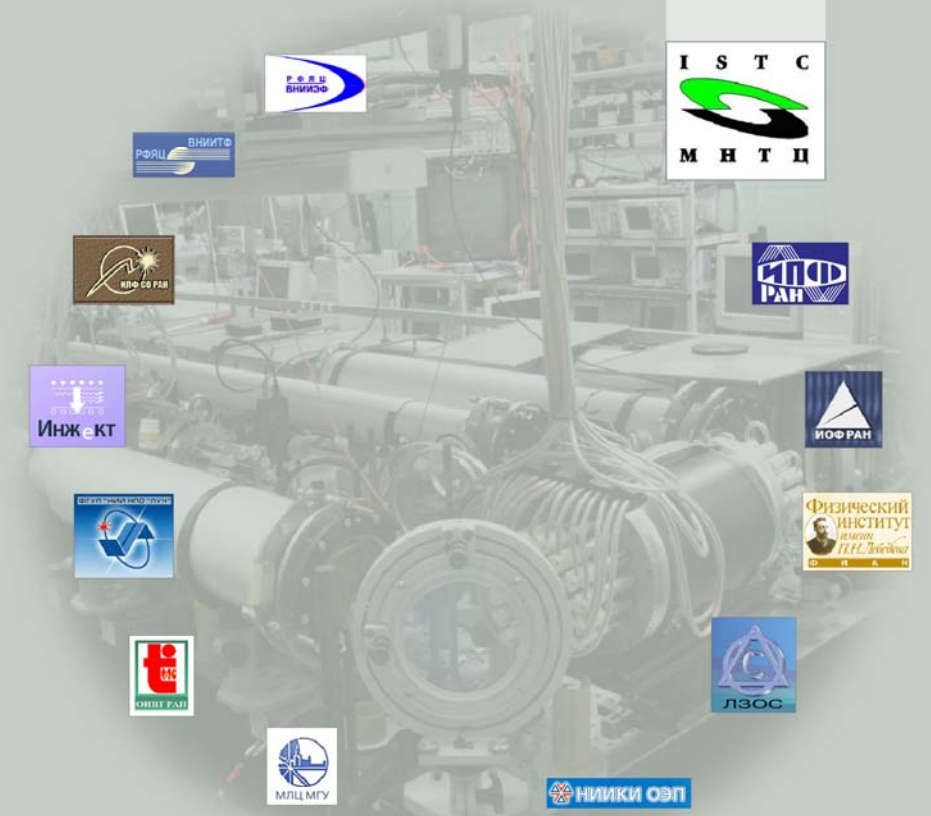
International Committee on Ultra Intense Lasers Conference
26 September–1 October, 2010, Watkins Glen, New York

The International Committee on Ultra-High Intensity Lasers

- A special ISTC session on the ISTC TI was organized within the frame of Conference.
- During this session both Russian Nuclear Federal Centers Sarov and Snezhinsk were presented to the international ultra-high intensity lasers community for the first time.

2010 ICUIL World Map of Ultrahigh Intensity Laser Capabilities





ISTC
МНТЦ

A special TI related booklet was developed and published in Russia under the ISTC sponsorship

List of the projects with participation of Russian institutions

Direction of research	Number of projects	Leading Institutes
Experimental and design-theoretical studies in the field of interaction of high-intensity laser radiation with targets	**10** **(Nos. 1,7,8,9,11,15,16,27,28,29 from Table 1.1)**	RFNC-VNIIEF, Sarov RFNC-VNIITF, Snezhinsk LPI RAS, Moscow ILC MSU, Moscow JIHT RAS, Moscow IAP RAS, Nizhny Novgorod GPI RAS, Moscow NIIKI OEP, Sosnovy Bor
Techniques and devices for measuring parameters of laser radiation and laser plasma	**4** **(Nos. 2,4,12,21 from Table 1.1)**	RFNC-VNIIEF, Sarov JIHT RAS, Moscow LPI RAS, Moscow ILC MSU, Moscow
Element base of laser systems with ultrashort pulse duration	**9** **(Nos. 5,13,17,18,19,20, 22,23,25 from Table 1.1)**	IAP RAS, Nizhny Novgorod "Inject" JSC, Saratov SPA "LUCH", Podolsk RFNC-VNIIEF, Sarov "LZOS" JSC, Lytkarino ILP SB RAS, Novosibirsk
Prospective developments	**6** **(Nos. 3,6,10,14,24,26 from Table 1.1)**	RFNC-VNIIEF, Sarov IAP RAS, Nizhny Novgorod GPI RAS, Moscow JIHT RAS, Moscow ILP SB RAS, Novosibirsk NIIKI OEP, Sosnovy Bor

List includes 29 proposals with total cost about 22M$

ISTC TI implementation has allowed members of the Russian Laser Community to consolidate their intellectual potential in solving challenging tasks of the contemporary laser physics

3rd International Symposium “Laser-Driven Relativistic Plasmas Applied to Science Energy, Industry, and Medicine”, 2011, May, 30 –June, 2

Kansai Photon Science Institute, Kizugawa, Kyoto, Japan

Visit to the Institute of Laser Engineering, ILE, Osaka University, June 2, 2011

Outputs of the visit :

-Visits to ILE, Osaka University (Prof.H.Azechi) and KEK, Tsukuba (Prof. K.Nakajima);

-Both VNIIEF and VNIIETF, were presented to Japanese community;

- Key interests and activities of Japanese laser community were presented;

- Better knowledge of peculiarities of Japanese and Russian science.

ISTC-GSI YOUNG SCIENTISTS SCHOOL 2011

"Ultra-High Intensity Light Science and Applications"

GSI, Darmstadt, Germany

2011, October 10 – 15

Key Topics :

- High energy laser-plasma physics
- Non-linear optics in relativistic regime
- Quantum electrodynamics in superstrong fields
- Absorption of intense laser radiation
- Advanced laser-plasma particle acceleration
- Relativistic nanoplasmonics
- Towards exawatt laser power
- Intense laser and particle beams

Information :

http://gsi.de/forschung/pp/dates/Agenda.html

Chairs : Karlheinz Langanke (GSI) and Adriaan van der Meer (ISTC)

Lecturers :

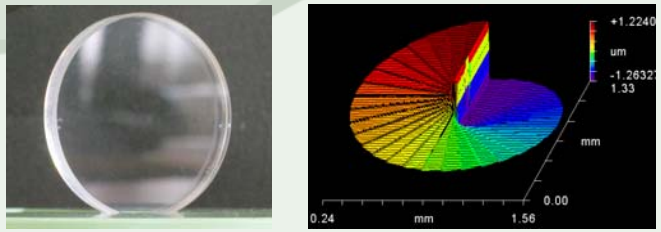
- **Gérard Mourou** (Laboratoire d'Optique Appliquée & ILE, France)
- **Alexander M. Sergeev** (IAP RAS, Russia)
- **Nikolai B. Narozhny** (MEPhI, Russia)
- **Sergei V. Bulanov** (KPSI, Kyoto, Japan)
- **Thomas Kühl** (GSI & Mainz University & Helmholtz Institute Jena, Germany)

Paricipants :

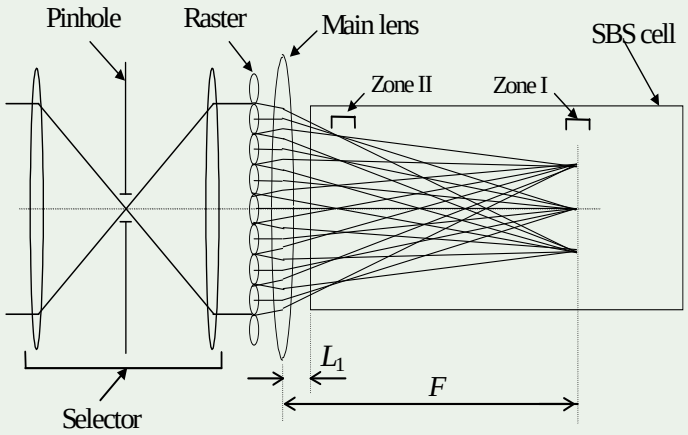
Students, post-graduates and post-doctorates under 35

ISTC Nonlinear Optics Activities

- Projects
- Workshops
- Travel



Unique kinoform spiral phase plate



List of Current Relevant Projects :

Status 2 :	1
Status 6 :	3
Status 8 :	28
Status 3 :	25
Status 4	3
TOTAL Number :	61

TOTAL COST : 8.3M$** **Project (AVR): COST - 268k$ **DURATION - 30 months**

Current Relevant Projects

I. Stimulated Brillouin Scattering

GOI, Serebryakov V
108 Pulse Compression Lasers (R)
TRINITI, Smirnov R. V.
591 Ultra-Bright Laser
VNIIEF, Starikov F.A., Pevny S N
945 Remote Sensing of Turbulent Atmosphere
1929 Phase Conjugation in Commercial Laser

II. Stimulated Raman Scattering

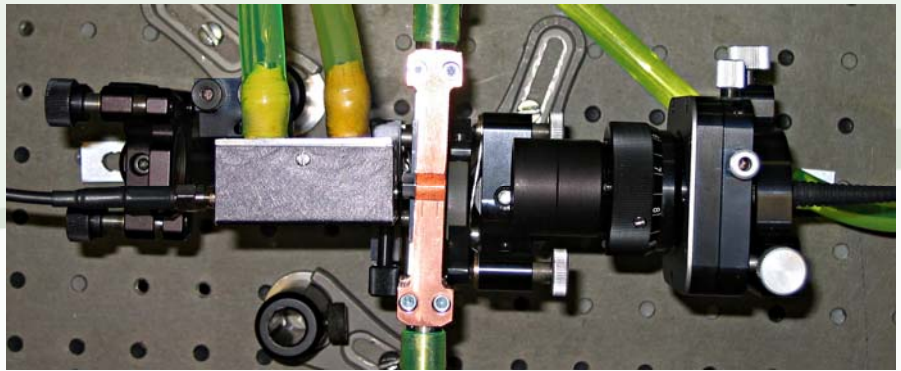
FIAN named after A.M. Prokhorov , Basiev T. T.
2022p New Active Optical Materials
B.I. Stepanov Institute of Physics Orlovich V. A.
B-079 Infrared Radiation Sources
B-266 Compact Solid State Laser
B-898 Low-Threshold Raman Converters
B-1679 Continuous Wave Laser with Intracavity Conversion

III. New Nonlinear-Optical Materials

VNIIEF, Rukavishnikov N N
3683 Photonic Crystal Fibers
Institute for Optical Monitoring, Gribenyukov A I
2051 Optical Crystals Growth from Melt and Vapo
NPO Astrophysica, Seregin A M
1857 New Crystals for Nonlinear Optics
PTI RAS, Sobolev N A
168 Erbium-Doped Silicon
Institute for Physical Research, Kokanyan E P
A-1033 Lithium Niobate Crystals

IV. Other Projects

Research Institute for Laser Physics, Mak A A
929 Energy Delivery Over Long Distances



SUMMARY 1

I. Stimulated Brillouin Scattering

- a detailed review of features, accompanying the occurrence of nonlinear optical SBS effect in different media and under different conditions,
- physical models, ensuring acceptable accuracy of engineering design, related to both individual elements and complex laser-optical systems,
- a base for design and development of prototype laser systems with unique parameters (aperture $\approx 10^{-4}$ rad, pulse energy ~ 1 kJ) and demonstration of possible new applications,
- engineering prototype laser-optical systems had been created, which were operating successfully for a number of years.

II. Stimulated Raman Scattering

The above cycle of projects served as a trigger to re-vitalize the interest of scientists from all around the globe in research and application of SRS effect, particularly, for design and development of coherent radiation sources

SUMMARY 2

III. New Nonlinear-Optical Materials

#3683:

These fibers were successfully applied for generation of supercontinuum at a low level of excitation with femtosecond pulses.

#2051:

Technology of growing high-quality ZnGeP2 crystals, possessing one of the record values of non linearity in the IR spectral region was developed

 # 1897:

Perfect large-size crystals were grown, their squared non-linearity, radial stability and thermal conductivity were measured. Tunable radiation was obtained (at signal and idle modes) within the region of 1.2 – 8.3 μm under the pumping of parametric generators with pulsed radiation of Nd:YAG laser first harmonic.

 # 168:

This material could be applicable for creation of emitting structures at 1. 54 μm wave length,coinciding with the minimum of absorption in fibers.

#A-1033:

- The development of technology for growing “periodically and chirped-periodically-poled” lithium niobate crystals,
- Development of several types of novel promising nonlinear-optical materials with the major application spheres being atmospheric optics and environmental protection.

SUMMARY 3

IV. Other Projects

#929 (Prof. A.A. Mack, Institute of Laser Physics) :

This project is unique in terms of a combination of the effects investigated and does not fall under the subject-related project taxonomy mentioned above.

- Dedicated to the problem of transport of high-intensity fluxes of laser power at large distances,
- Addressed a number of issues, related to the design of architecture of optical systems, incorporating a set of laser modules, laser beam extenders with segmented mirrors, based on adaptive optics and wave front adjustment principles, ensuring resolution of the problem of coherent summation of several laser channels and compensation of distorted beams,
- Resulted in the design, development and testing of key elements of laser nonlinear optical systems, ensuring the solution of the indicated problem.

It is noteworthy, that in terms of ideas and results obtained this project is especially valuable, as super-high intensity laser systems are currently under development and transport of such radiation at large distances becomes even more relevant.

ISTC: Way Forward

Background for future development

- Withdrawal of the Russian Federation from the ISTC Agreement and Protocol, announced in Decree #534 of President Medvedev from 11 August 2010
- ISTC without the Russian Federation: shifting the focus of activities to other CIS states and Georgia, moving the Secretariat Headquarters to Almaty
- 13 July 2011- the MFA of Russia officially informing the Parties of the RF intention to withdraw from the ISTC by mid 2015

THANK YOU FOR ATTENTION

Questions?