Coordination Committee / Governing Board
Document Cover Sheet

A new Targeted Initiative "Ultra-High Intensity Light Science and Technologies", UHILS&T (TI) is submitted to the Government Board for consideration and approval.

One of the main objectives of this TI is to develop an International partnership in the domain of high power and high intensity lasers to extend the frontiers for fundamental science, material processing and medicine through coordination of activities of research centers, governmental agencies and private organizations.

The proposed financing of this new TI is:

- ISTC contribution: USD 4,000,000 for 3 years. Initial phase 2010: 300 000$
- Russian Federation contribution: USD 1,800,000 (see support letter to ISTC ED from A.V. Gaponov-Grekhov,ED-CP-035, dated on 13-10-2009)

Proposal

The Board is requested to make the following decisions:

- to approve the proposed Targeted Initiative "Ultra-High Intensity Light Science and Technologies", UHILS&T;
- to agree to the funding proposal as mentioned above.

ULTRA-HIGH INTENSITY LIGHT SCIENCE AND TECHNOLOGIES - TARGETED INITIATIVE

1. Introduction

In recent years development of intense coherent light sources opens new opportunities for science and technology in different fields. Ultra-relativistic physics in extreme states of matter will drastically move boundaries of our understanding of the Universe and may also contribute to sustainable solution of energy supply for mankind.

Many research activities in this field are going on internationally.

Europe:

At the end of 2006 a consortium of European countries began implementation of three unique science and technology projects - ELI, HiPER and PETAL, which may lead to a breakthrough in certain areas of contemporary natural science. In the long run the outcome of these projects may result in practical development of technologies, related to controlled nuclear fusion, making up the foundation of energy of the future; particle acceleration to ultra-high energies on a laboratory scale and to other unique technologies.

The major project Extreme Light Infrastructure, **ELI**, will be a unique research infrastructure open to scientists dedicated to the investigation and applications of laser-matter interaction at the highest intensity levels. The core of ELI will consist of a laser producing pulses with a peak power of 200 quadrillion Watts, i.e. 0.2 Exawatt, by coherent combining radiation of several laser channels. ELI will attain this unprecedented power from the confinement of a moderate amount of energy (about 3-4,000 Joules) to within an extremely short interval of time: about 10 quadrillionths of a second, i.e. 10 femtoseconds. ELI's peak power will – in spite of its moderate energy – outperform the most powerful lasers existing in the world by a factor of 100-1000. ELI will be a super-intense infrared femtosecond laser, which will be in the ultra-relativistic regime of laser-matter interaction (with intensities above 10^{24} W/cm^2) and will enter the regime of nonlinear laser-vacuum interaction using new relativistic compression schemes.

The European High Power Laser Energy Research facility, **HiPER**, is a project dedicated to demonstrating the feasibility of laser driven thermonuclear fusion as a future energy source. Its principal mission is to generate an energy gain of a factor of 100. It will also enable a broad range of fundamental research, including material at extreme conditions, modeling of astrophysical processes in the laboratory, industrial and medical applications. The HiPER project already has formal involvement from seven European nations, along with the involvement of scientists from eight other nations, including the USA, Japan, Canada and Republic of Korea.

PETAL is a 3.5 kJ, 0.5 – 10 ps, PetaWatt-class laser which is under construction in the Aquitaine region, France. It is a forerunner to the HiPER facility, carrying out research on inertial confinement fusion physics by using the fast ignition approach and fundamental physics. Its mission is to address the physics and technology issues of strategic relevance for fast ignition and provide a framework for the basic studies of the properties of matter in extreme conditions.

USA:

Fusion in particular and high-energy-density physics in general, are the foci of the National Ignition Facility, **NIF**, Lawrence Livermore National Laboratory, Livermore, CA, USA. Originating in the form of an official design report issued in 1994, NIF recently reported historic scientific advances. In March 2009 NIF became the first fusion laser in the world to break the megajoule barrier by delivering 1.1 MJ of ultraviolet energy to the center of its target chamber - more than 25 times more energy than the previous record-holder. Experiments will ramp up with the goal of increasing the total power generated by the facility's 192 combinable lasers to the tens of megajoules, eventually having a stable burning platform inside three years that will be made available for high-energy-density researchers from around the world. Ultimately, yields of up to 100 MJ should be possible.

Canada:

The Advanced Laser Light Source ALLS is a Canadian based International Research Facility that has been established to explore a completely new approach to dynamic investigation of matter. The first beam time to external user started in 2005. ALLS was one of the three Canadian project granted by the CFI Canada fund international project and consists of a femtosecond multi-beam lasers national facility. ALLS is also a consortium of 14 Canadian universities, three government laboratories and 17 international institutions. The central concept behind ALLS is to use multiple laser beam interactions, from X-rays to the infrared, with sufficient power to manipulate the matter and probe its dynamics. The heart of the ALLS facility is a high technology multi-beam laser system based on the most recent ultrafast Ti:Saphire technology. These various sources contribute to a « rainbow of light », which emits high photon fluxes with femto- and attoseconds pulses at different wavelengths.

Japan:

The Japanese FIREX (Fast Ignition Realization EXperiment) program is well under way to experimental implementation of the principle of fast ignition.. The FIREX program has two phases. The goal of FIREX-I is to demonstrate the fast heating of a fusion fuel up to the ignition temperature of 5-10 keV, and the ignition and burn for FIREX-II. In FIREX-I, the existing GEKKO-XII laser is used as an implosion laser with 10-kJ and ns-duration. The LFEX (Laser for First Ignition EXperiment) laser system is under construction as a heating

laser with 10kJ/10ps with four beams. The chirped pulse amplification has been demonstrated with kJ-class output pulse energy by using one of four beams in the LFEX laser. Osaka University and NIFS collaborate in the FIREX project in target fabrication, simulation, and experiment.

Russian Federation:

In the Russian Federal Nuclear Centre – All-Russian Scientific Research Institute of Experimental Physics, RFNC-VNIIEF, Sarov, Russia, a new science – physics of high energy densities - was founded and evolved. This science lies in the field of intersection of such physical areas as hydrodynamics and physics of explosion, nuclear physics, plasma physics, applied mathematics, a creation of special physical facilities and diagnostic complexes, connected, first of all, with the whole system of physical sciences. Since middle sixties of last century works on the high-power laser creation and their application for an investigation of physics of high energy densities have been developing actively in RFNC-VNIIEF. In the RFNC-VNIIEF there are several high power lasers to study physics of hot dense plasma on the problem of laser fusion.

Laser «ISKRA-5» has parameters - E_L=30 kJ, λ=1.315 μm, τ_L=(0.3-0.5) ns, and used for the research on physics of indirect drive targets.

Laser «LUCH» has the following parameters E_L=12 kJ, λ=0.35 μm, τ_L=(1-3) ns, and used as for the study of direct and indirect drive targets, as for test of technical solutions to be used in laser «UFL-900».

Laser «UFL-900» has the following parameters E_L=900 kJ, λ=0.35 μm, τ_L=(1-5) ns, and used as for the study of indirect drive targets and physics of high energy density.

The start-up of “Luch” facility opens new prospects for carrying out of fundamental and applied experimental investigations on interaction of high-intensity laser radiation with matter. RFNC-VNIIEF together with the Institute of Applied Physics of Russian Academy of Science, IAP RAS, N. Novgorod, has been started the works on creation of a Petawatt laser system on the basis of the “Luch” facility channel.

The interaction chamber has a set of diagnostics to measure plasma parameters, characteristics of X-rays and charged particles that are generated when high-intensity ultra short laser pulse irradiates the target.

Theoretical investigations and calculations are performed and a number of perspective target designs are carried out in the RFNC_VNIIEF. It was shown that in the experiments with these targets it is possible to obtain high value of proton energy accelerated in laser field with ultra short duration.

The Russian Federal Nuclear Center – Zababakhin All-Russia Research Institute of Technical Physics, RFNC-VNIITF, Snezhinsk, Russia carries out experiments on physics of high energy density on SOKOL-P laser facility. SOKOL-P is Nd:glass laser with pulse energy up to 15 J and pulse duration 0.7.. 0.8 ps, and intensity on target is more 1019 W/cm2.

This experiments deal with the study of the following topics:

- Proton acceleration
- X-ray lasing
- Fast electrons generation and transport
- DD, DT Neutrons generation.

Novel laser plasma diagnostic instruments are developed in the RFNC-VNIITF, in particular:

- Time of Flight, TOF, and Scintillation spectrograph of protons
- X-ray microscope
- X-ray spectrograph

The RFNC-VNIITF develops research on laser targets, in particular, ‘’Microdot’’ targets, ultrathin films from organics and metals, porous metal targets.

Current scientific research provides important benefits to future technologies. The spread of scientific results is rapidly providing state and non-state players worldwide with easier access to knowledge.

New laser developments pose new challenges to international and national authorities in their efforts to regulate the acquisition of knowledge, especially with regard to these highly sensitive materials and technologies.

2. Potential for international cooperation

Various international and national organizations have responded to the outlined concerns, albeit from different angles. A number of examples are mentioned below. The national programs in France (Centre National de la Recherché Scientifique, CNRS), UK (Science and Technology Facilities Council, STFC) and Germany (Gesellschaft fur Schwerionenforschung mbH, GSI) offer opportunities for mobility and specific project collaboration: bi-lateral lab-to-lab projects, visiting professor invitations, and networks on specific scientific problems of high field science with lasers.

The ELI project offered a more straightforward involvement in projects by inviting the Russian Federation to participate in the ELI (ILE) consortium.

The HiPER project has two official partners in Russia. One partner is the Institute of Applied Physics of the Russian Academy of Sciences, IAP RAS, and Nizhny Novgorod,

which has direct contract with HiPER. The other partner, the P.N. Lebedev Physics Institute of Applied Physics of the Russian Academy of Sciences, LPI RAS, Moscow, conducts research for the needs of HiPER through the ISTC Partner Project Program.

The Russian Foundation for Basic Research of the Russian Academy of Sciences, RFBR RAS, has performed interdisciplinary basic research (005 – Basic research in high laser field matter interaction) for 2009-2010.

In addition, the Russian Academy of Sciences Presidium has launched Program #9 of the basic research on "Extreme light fields and their applications", which is headed by academicians S. Bagaev and A. Gaponov-Grekhov.

The Russian Federation Ministry for Education and Science has held invitational open tenders on Point 1.1 "Science Research, Involving Teams from Research and Educational Centers" of the Federal Targeted Program "Research, Science and Educational Personnel of an Innovative Russia" for 2009 – 2013.

Thus, there is no intergovernmental agreement between the Russian Federation and France, the UK, or even the above-mentioned European projects that regulates participation of Russian institutions in the development of this scientific research and new laser technologies.

In this crucial process the ISTC may act as either an intermediary or a coordinator. The ISTC can help to establish a network of collaboration between leading European institutions and key Russian institutions.

3. International Science and Technology Center (ISTC)

The ISTC has promoted cooperation in this domain through ISTC projects (regular and partner). The ISTC has considered 14 projects in this domain for funding. 8 projects have been funded for a total amount of 2.3 M$USD.

In the middle of 2008 scientists from a number of RF institutes appealed to the ISTC Secretariat, suggesting that a couple of new ISTC Projects be prepared on this topic, linked to basic research of physical processes in the field of high-energy-density physics, based on high power short pulse laser installations.

Taking into account this appeal, the ISTC Secretariat decided to hosted an International Workshop "Russian ELI/HiPER/PETAL at the ISTC" at its premises in Moscow, on November 24-25, 2008 (for more information see the ISTC website <http://www.istc.ru/ISTC/ISTC.nsf/va_WebPages/LaserEng>).

The Moscow Workshop helped identify high-priority subjects and research groups interested in collaboration on all the three above-mentioned EU projects.

Three months later, the ISTC, jointly with Centre d'Etudes des Lasers Intenses et Applications, CELIA, University; Bordeaux 1, France, ILP, and the Russian Academy of Sciences, organized and financially supported the Franco-Russian ISTC Workshop on Physics with PETAL and the diagnostic development, which was held in Bordeaux, 8-11 March 2009 (for more information see the ISTC website <http://www.istc.ru/istc/istc.nsf/va_WebPages/PetalWSEng>).

The participants of the Bordeaux Workshop proposed ideas for future collaborative projects, implying further experiments, development of diagnostic and large optical equipment for the PETAL installation.

A Memorandum of Understanding, MOU, between the French Association on Lasers and Plasmas and the Federation of Research Lasers and Plasmas being one party and the RAS and the ISTC being the other parties, was signed in Bordeaux in March 2009.

After the Bordeaux Workshop on April 17, 2009, a Joint ILC MSU-LPI research laboratory "Relativistic Laser Plasma" was established.

The ISTC has financially supported the first Russian-French-German Laser Symposium, RFGLS 2009, in Nizhny Novgorod on17-22 May 2009. The principal goal of the workshop was to discuss recent results and advances made in the physics of high-intensity laser fields, in quantum and atomic optics, high-precision measurements, application of lasers in biomedicine, nanophotonics and others. The workshop provided a wide exchange of research achievements and ideas, mutually beneficial international collaboration in science and technology, and coordination of fundamental and applied research in the above-mentioned fields of science.

Furthermore, the ISTC, jointly with the Institute of Applied Physics of the Russian Academy of Sciences, IAP RAS, which is an official partner of the HiPER project in Russia, has organized the first UK/Russia ISTC workshop on HiPER, which following on from an ISTC meeting in 2008 in the area of high intensity laser science. The first workshop was hosted by IAP RAS on November 3-4, 2009. Representatives of 14 Russian institutions met with 3 senior members of the HiPER management team (M Dunne – Project Coordinator, C Edwards – Project Director, J Collier – Chief Scientist) to explore the collaborative options for the immediate term and next phase delivery. The second is expected to be held in February 2010 in London or Oxford, UK.

This workshop identified a broad range of subject areas with a high degree of overlap between the capabilities of these institutions and the requirements of the HiPER project.

The ISTC should take advantage of the experience and know-how it has gained.

In its view, integration of the knowledge and potential accumulated by the Russian-European laser community would, on the one hand, facilitate an accelerated integration of Russian scientists into the process of implementing the European ELI/HiPER/PETAL projects, while on the other; it would facilitate the development of a Russian Federation national project in this field of research.

4. Objectives of the Targeted Initiative

Ultra-high intensity light science and technologies is a very broad and promising area of research, which encompasses all three above- mentioned EU projects. International cooperation in this domain deals with dual-use research and technology. The ISTC promotes and facilitates a "responsible science approach" and responsible knowledge management. The ISTC framework is a very efficient tool to minimize and prevent risk in cooperation with Russian Partners in S&T due to its legal status and well-established mode of operation.

A new Targeted Initiative "Ultra-High Intensity Light Science and Technologies" was proposed by participants of the International Workshop "Russian ELI/HiPER/PETAL at ISTC" in November 2008. This Targeted Initiative was lunched at the end of summer 2009, when ISTC received letters to support the development of this TI:

France - Prof. G. Mourou, ELI Coordinator, UK – Prof. M. Dunne, HiPER Project Coordinator, Germany – Prof. O. Willi, DFG SFB/TR18 Project Coordinator, Russia - Russian Academy of Sciences (Prof. A. Litvak, IAP, N. Novgorod), and Russian Institutions of Rosatom Corporation - Dr. V. Kostyukov, RFNC-VNIIEF, and Prof. G. Rykovanov, RFNC-VNIITF.

It is noteworthy that the proposal attracted the attention of numerous Russian institutes of different agency-level subordination, as follows: P.N. Lebedev Physics Institute RAS (Prof. O. Krokhin) and A. Prokhorov General Physics Institute RAS, (Prof. I. Sherbakov, Director), both Moscow, Joint Institute for High Temperatures RAS (Prof. V. Fortov, Director), Moscow, Vavilov State Optical Institute, GOI, (Prof. A. Andreev), St Petersburg, Moscow State University, National Research Nuclear University Moscow "MEPhI"(Prof. N. Narozhny), Institute of Laser Physics SB RAS (Prof. S. Bagaev, Director), and others.

Successful development of this domain needs public and governmental support. Russian and European Institutions realize that participation of American, Canadian and Japanese institutions in this Targeted Initiative could be useful and mutually interesting.

Advancement in the design and production of high-power Petawatt laser systems in the world is largely defined by the outcome of NIF Project. Experience, gained during the NIF

Project implementation will be taken into account both in the creation of ELI laser system and in the course of HiPER Project implementation, which implies addressing quite a number of engineering and technological tasks. The state of the art of the HiPER Project is defined as preparation of performance specification and definition of technical requirements for the work to be performed. Addressing the tasks of the preparatory stage demands employment of interdisciplinary expertise and know-how. The ISTC Targeted Initiative will be focused on projects, oriented to theoretical and experimental simulation of processes, related to laser radiation interaction with the matter at the ultimate intensity; exawatt laser testing; diagnostics and creation of large-scale optical devices. The format of the Targeted Initiative will ensure ultimately flexible and efficient use of the provided funds and re-arrangement of funds depending on the results, arising from implementation of the earlier objectives.

The objective of the Targeted Initiative is to develop a European partnership in the domain of high power and high intensity lasers to extend the frontiers for fundamental science, material processing and medicine through **coordination of activities of research centers**, **governmental agencies and private organization**s. Russian/CIS scientists will directly participate in planning and construction of the EU laser facilities and will have privileged access to them thereafter. Complementary competences and expertise will be very effectively explored resulting in technological excellence and economical efficiency.

This Targeted Initiative is aimed at the following results:

- To develop a Program of scientific cooperation for ELI/HiPER/PETAL projects in the following fields:
  - High field science with lasers
  - Inertial fusion energy
  - Laboratory astrophysics with lasers
  - Other civilian applications
- To develop collaborative research projects of mutual interest concerning the fundamental physics of high-intensity laser-matter interaction and diagnostic development for PETAL as following:
  - Preplasma diagnostics
  - Proton streak camera
  - High resolution X-ray spectroscopy
  - K-alpha imagery
  - Transmission spectrometry
  - Thomson spectrograph
- To develop collaborative research projects of mutual interest concerning the ELI project as follows:
  - Design and construction of a 10 Petawatt laser facility that may serve as a prototype of one channel of the ELI complex

  - Establishing a new factory of large-aperture nonlinear KDP crystals that would serve to equip ELI and HiPER complexes with unique laser components
  - Theoretical and experimental studies of processes of laser-matter and light-particle interaction at highest intensity levels
- To coordinate HiPER and Russian group activities and understand better the Russian capabilities and potential by proposing collaborative research projects of mutual interest in the following areas:
  - High-peak power laser development
  - High average power lasers
  - Optics supply
  - Targeting: manufacture, injection and tracking
  - Fusion reactor research (materials, design, etc)
- To facilitate terms of collaborative activities between European scientific projects and the Russian Federal Nuclear Center VNIIEF, Sarov, including further experiments, on the FEMTO Facility, diagnostic equipment, etc

- To encourage participants of this Targeted Initiative to strengthen the involvement of the ISTC Partner Projects Program as an effective instrument for implementation of collaborative research projects of mutual interest

- To encourage participants of this Targeted Initiative to get broadly involved in the ISTC Specific Training and Partner Promotion Programs to improve their professional skills and to acquire new skills in handling new (experimental) equipment

- To develop projects assisting in the development of adequate emergency planning, reporting, first response, etc.

Stronger coordination with other international and governmental organizations will be carried out through project funding aimed at upgrading R&D and infrastructure. A detailed implementation plan will be established, which will also pay attention to issues of intellectual property protection.

A more detailed program for the first phase of the Targeted Initiative is given in the Annex V in a form of project proposals which were already discussed and preliminary agreed between partners.

5. Organizational Set-up

a. Steering Committee (SC)

A Steering Committee (**SC**) will be established, with a maximum of two members appointed by each participating national funding Party/Partner. Generally, one of these members will be a technical expert (see Annex I for a draft Steering Committee).

The Russian Federation (when it confirms its interest) will be represented on the **SC** by one technical expert or representative, and by one of the organs of State power authorized to give host government concurrence to projects, should they choose to participate.

The ISTC Secretariat also will have an **SC** member.

To minimize travel expenses, the **SC** will conduct most of its work via periodic electronic communications, but it will meet in person at least annually.

b. The Role of the ISTC Secretariat

This TI will operate under the Secretariat's Science and Technology Department 1 (ST1) and its Deputy Executive Director. The DED-ST1 will also be responsible for and in charge of all reporting. The DED-ST1 will designate an SPM to co-ordinate the **SC**.

c. The Role of National Funding Parties/Partners

Parties/Partners that choose to participate will each *voluntarily set a notional funding level for a three-year period*, subject to their respective fiscal and budgetary constraints. The Parties/Partners intend to obligate funds for the first year to the ISTC; however obligated funds will be actually expended according to the directions of each respective Party/Partner. It is anticipated that there will be some jointly funded projects as well as other support activities as specified above. Finally, supplementary budget funds may also be used as are deemed appropriate by the Parties/Partners.

Co-funding from host government agencies is being actively sought by the Secretariat. It is assumed that such co-funding would be applied to agreed activities in parallel, rather than being funneled through the ISTC which currently has no approved mechanism for accepting co-funding for projects or SB activities from host governments. Any co-funding from the State, agencies, academies of science and business should generally be considered a plus in consideration of the R&D projects or other activities submitted by the institutes for funding.

Cooperation between Russian and other CIS institutions and European and other western countries laser community in the domain of extreme light science and technologies is developed with the ISTC Partner Project Program as a driving force.

6. Functioning

After approval, this TI will be principally conducted using the ISTC's "model project agreements" with the possibility of some minor changes and modifications. Dependent upon the actual funding source, R&D and infrastructure upgrades will be mostly either regular or Partner projects, which will be concurred and approved for funding via the ISTC's approved project procedures. Additionally there will be some non-project support activities, including training sessions and certification activities. These activities will be developed using established ISTC mechanisms (e.g. workshop agreements, competency building, mobility support, etc.) for their implementation.

Any IPR created in the performances of its projects or other support activities will be allocated according to the legislations of the recipient countries and ISTC statute documents.

a. Annual Work Plan

An annual plan will be prepared by the Secretariat and proposed to the **SC.** It will include a call for proposals, technical workshops, participation in targeted scientific and business events or training, etc.

b. Targeted Call for Proposals (CFPs)

The Secretariat is developing and will concur with the **SC** the text for the Call for Proposals (CFPs), including the (see Annex II for a draft Call for Proposals):

(i) Technical topics of interest,

(ii) Expected project duration, and

(iii) Funding parameters

Information on CFPs will be distributed by the ISTC to the priority institutes, placed on the ISTC website, and responsive project proposals should be prepared in standard ISTC project proposal format and in accordance with the ISTC approved project preparation procedures. Institutes may also be requested to initially provide a brief abstract of their concepts for review by the **SC** before proceeding with a full proposal. A template will be provided.

c. Project Selection

The organs of State power authorized to provide host government concurrence are requested to make their best efforts to facilitate and expedite the granting of host government concurrence for these projects and especially for those associated with the CFPs.

Following the completion of appropriate host government concurrence processes, the Secretariat will receive and manage those responsive project proposals[1] and distribute them to the SC members for technical review. Upon a Party/Partner's request, in parallel, the ISTC's Scientific Advisory Committee will be provided with copies and afforded a four-week period for either its negative concurrence or comments.

During the project proposal review, the SC will give full and fair deliberation to all concerns/objections that may be raised by any Party/Partner, and SC members will recommend to their respective national Parties/Partners projects and funding. Each SC-recommended proposal shall additionally be subject to negative concurrence in accordance with ISTC's procedures.

Depending upon when, during the year, selection and funding recommendations are provided, these projects may be funded either (a) "in-cycle," *i.e.* coincident with regular GB funding sessions or (b) "out-of-cycle" *i.e.* by written procedures.

d. Operational Review of Ongoing Projects

The ISTC Secretariat will be responsible for the management of ongoing projects and support activities.

e. Support Activities

The ISTC Secretariat will be principally responsible for the organization and management of related working meetings with the participation of recipient institutes, Russia and other CIS organs of State power, the private sector, and national funding Parties/Partners. The SC may exercise an oversight function regarding these meetings. As part of its annual plan, using supplementary budgets, the SC may decide on other support activities, such as technical workshops, training events, and the provision of technical experts or R&D outreach.

f. Reporting

The ISTC Secretariat will ensure reporting to the Parties, through its quarterly and annual reports, as appropriate.

Moreover, the Targeted Initiative will report annual work progress to the Scientific Advisory Committee and – if so requested – to the ISTC Governing Board.

[1] The UHILS&T-TI Coordinator will liaise with other parts of the Secretariat with regard to insuring the proper registration and processing of these responsive project proposal submissions.

g. Funding

The budget for this TI will be partially comprised of two parts: project funding and supplementary budget. In addition, the Secretariat intends to approach other funding sources for the financing of this Targeted Initiative (see below under Annex III). The proposed annual distribution of funds, without prejudice to regular budgeting procedures, is as follows:

UHILS&T-TI Budget (US $)	Year 2010	Year 2011	Year 2012
Supplementary	50,000	50,000	50,000
Project	250,000	1,800,000	1,800,000
Total	*300,000*	*1,850,000*	*1,850,000*
GRAND TOTAL	$4,000,000		

7. Timing

GB 50 Decision – December 2009

CFP announcement – March 2010

CFP Deadline – June 30, 2010

Review Deadlines – August 31, 2010, and December 31, 2010.

The Targeted Initiative will be implemented through the following steps:

Step 1: Identify countries in which the ISTC operates that are interested in participating and Parties organizations and agencies the responsibilities of which overlap with this TI;

Step 2: Establish a Steering Committee (SC) with interested Funding Parties and CIS members;

Step 3: Prepare a call for proposals, focusing on agreed subject areas, by the SC;

Step 4: Identify Status-3 ISTC projects for financing that fit the TI objectives;

Step 5: Sponsor various technologies that might be used in the solution of specific problems of high intensity laser physics projects;

Step 6: Sponsor working meetings and training sessions;

Step 7: Support for new initiatives by the ISTC and/or Parties.

Annex I
Steering Committee

A Steering Committee (**SC**) will be established, with a maximum of two members appointed by each participating national funding Party/Partner. Generally, one of these members will be a technical expert.

Russia (when it confirms its interest) and other CIS countries will be represented on the **SC** by one technical expert or representative, and by one of the organs of State power authorized to give host government concurrence to projects, should they choose to participate.

The ISTC Secretariat also will have an **SC** member. To minimize travel expenses, the **SC** will conduct most of its work via periodic electronic communications, but it will meet in person at least annually.

Annex II
Draft Targeted Call for Proposal

ULTRA-HIGH INTENSITY LIGHT SCIENCE AND TECHNOLOGIES - TARGETED INITIATIVE (UHILS&T-TI)
CALL FOR PROPOSALS

1. ULTRA-HIGH INTENSITY LIGHT SCIENCE AND TECHNOLOGIES - TARGETED INITIATIVE

The ISTC's Ultra-High Intensity Light Science and Technologies Targeted Initiative is a new partnership effort to promote greater focus and coordination for existing ISTC projects and identify new ISTC projects that help develop a cross-section of European laser community activities with those in Russia and other CIS countries, as well as to gain an understanding of the Russian and other institutes' capabilities and potential opportunities for the implementation of collaborative research projects of mutual interest in high-power and high-intensity lasers.

This Targeted Initiative will focus on ISTC projects that provide theoretical and experimental simulation of processes of laser-matter interaction at the highest intensity levels, testing of Exawatt laser crucial technology, diagnostic and large optics equipment development.

The principal goals of this Targeted Initiative are to:

- Contribute to the ISTC's partnership in the domain of high-power and high-intensity lasers;
- Strengthen the efforts of existing related initiatives at the ISTC;
- Foster self-sustaining goals of select institutes;
- Support international collaboration.

This Targeted Initiative will be implemented using a phased approach over a three-year period in the following Steps:

Step 1: *Identification of CIS and Parties organizations and agencies whose goals converge with this TI;*
Step 2: *Establishment of a Steering Committee (SC) with participating funding Parties and CIS members;*
Step 3: *Preparation of a targeted call for proposals focusing on agreed priority areas by the SC;*
Step 4: *Identification of existing but not funded ISTC projects that fit the TI objectives;*
Step 5: *Financially support various technologies that might be used in the construction of the EU laser facilities;*
Step 6: *Co-funding for workshops, seminars, conferences and training on the improvement of professional skills and acquisition of new skills in handling new experimental equipment;*
Step 7: *Support for new initiatives by ISTC and/or Parties/Partners related to the development of ultra-high intensity light science and technologies. This first*

Targeted Call for Proposals is the next step in implementation of the Targeted Initiative.

2. TECHNICAL TOPIC AREAS [example]

The ISTC is seeking new and/or improved technologies to address the following priority areas:

- Theoretical and experimental simulation of processes of laser-matter interaction at highest intensity levels;
- Exawatt laser crucial technology testing;
- Diagnostic development for high intensity laser-matter interaction;
- Large optics supply;
- Targets: manufacture, injection and tracking;
- Fusion reactor research (materials, design, etc).

3. ELIGIBILITY

ISTC Project Proposals are invited from CIS institutes and other research facilities that meet the ISTC's standard eligibility requirements and which have research capabilities that are relevant to these priority areas.

Partnerships and co-funding with CIS and other international commercial entities are encouraged so that successful research products can be quickly manufactured and used.

The relevant academies of science may be consulted during proposal preparation and may be invited to participate in the definition of proposal priorities.

4. AWARD INFORMATION

4.1. Funding parameters:

Overall funding for the **UHIS&T-TI** is $4.0 M over three years
Co-funding from RF is $1.8 M over three years

4.2. Project duration:

Projects should complete their work within 1-2 years of Project Agreement signing.

5. SUBMISSION REQUIREMENTS

All proposals must be submitted in current ISTC format for regular projects based on the standard requirements provided on the ISTC website (<http://www.istc.ru/ISTC/sc.nsf/html/documents-proposal-preparation>). This includes the requirement to have a scientific partner (collaborator) from at least one of the ISTC UHILS&T-TI funding parties (EU, Canada, US, Japan) and Host Government concurrence (from the Russian Federation and other CIS countries). For identification purposes, the title of the proposal should start with the abbreviation "UHILS&T-TI" followed by a dash (eg." UHILS&T-TI - ……..")

The respective funding party, no later than one month after a decision on funding, will identify project collaborators for selected proposals, in the event that the proposing Institute has been unsuccessful in finding a collaborator.

6. POTENTIAL FOR CO-FUNDING

A Targeted Initiative Steering Committee (SC) will review all eligible proposals, in consultation with scientific and related experts, and provide recommendations to the Funding Party(s) for a final decision. Proposals selected for funding will be processed by the ISTC in an expedient manner. Proposals will be evaluated on the basis of: (1) responsiveness and relevance to the specific topic areas described above; (2) clarity and quality of the scientific approach proposed to achieve the project goals; (3) adequacy of the proposed project equipment/facilities, schedule, and cost to complete the work; (4) support of Party collaborators or Partners; and (5) percentage of former WMD scientists. Specific deliverables and products of the work should be clearly identified. Standard ISTC project reporting requirements will have to be followed.

In their funding decisions for projects in the above areas, the Parties/Partners will give due consideration to the applicable laws and policies in their home countries as well as in recipient countries, with respect to privacy and ethics.

A Model Application Form is attached

7. SUBMISSION DEADLINE

The ISTC Project Proposal Group (PPG) will begin accepting proposals on March 1, 2010. All proposals must be received no later than 5:00 pm, June 30, 2010. Host government concurrence is required for all proposals prior to submission. Funding Party decisions and successful proposal notifications are expected by September 15, 2010.

8. FOR MORE INFORMATION

ISTC point of contact: Dr Yuri Malakhov – phone: (495) 982-3157, e-mail: malakhov@istc.ru

Annex III
List of possible funding partners

The implementation of three unique science and technology projects - ELI, HiPER and PETAL, which may lead to a breakthrough in certain areas of contemporary natural science and may result in practical development of technologies, related to controlled nuclear fusion, making up the foundation of the energy of future, particle acceleration to super high energies on a laboratory scale and to other unique technologies. Organizations such as CEA and CNRS, France, CSI, Germany and STFC, UK, have been engaged in an on-going effort to develop a European partnership in the domain of high power and high intensity lasers for many years.

In developing the TI strategy, the ISTC has undertaken extensive consultations with many key partners working jointly with Russian institutions to solve various problems related to the field of high-energy-density physics based on high-power short-pulse laser systems, to ensure that the ISTC's efforts are complementary to the work of these other organizations and to identify areas of collaboration.

By focusing on specific areas and through a concerted effort with numerous public and private sector partners, the ISTC expects to have a significant impact on acceleration of integration of Russian scientists into the process of implementing the European ELI/HiPER/PETAL projects, and on the long-term sustainability of these efforts.

The prospective Funding Sources and Partners for this TI:

- Europe Scientific Co-operation Office
- European projects
- French G8 Global Partnership Program
- Science and Technology Facilities Council (STFC), Didcot, UK
- Helmholtz Association

The prospective Co-funding Sources in Russian Federation for this TI:

- Russian Academy of Scientists, RAS
- Russian Fund for Basic Research, RFBR, RAS

Annex IV
List of supporting documents

1. Letters of support for the Targeted Initiative

1.1 **EU**:

1. **France** - Prof. G. Mourou, ELI Project Coordinator
   ED-CP-020 dated on 15.07.2009
2. **UK** - Prof. M. Dunne, Director, UK Central Laser Facility, project Coordinator HiPER, Visiting Prof., Imperial College, London
   ED-CP-019 dated on 15.07.2009
3. **Germany** - Prof. O. Willi, DFG SFB/TR18 Project Coordinator
   ED-CP-021 dated on 15.07.2009

1.2 **Russian Federation**:

1. **Russian Academy of Sciences:**
   - Prof. A. Litvak, Institute of Applied Physics Director, N. Novgorod,
     ED-CP-018 dated on 15.07.2009
2. **Institutions of Rosatom Corporation**:
   - Prof. V. Kostyukov, Russian Federal Nuclear Centre – All-Russian Scientific Research Institute of Experimental Physics, RFNC-VNIIEF, Sarov
     ED-CP-033 dated on 23.09.2009
   - Prof. G. Rykovanov, Russian Federal Nuclear Center – Zababakhin All-Russia Research Institute of Technical Physics, RFNC-VNIITF, Snezhinsk
     ED-CP-034 dated on 06.09.2009

2. Letter from Russian Academia of Sciences, RAS, Academician A. V. Gaponov-Grekhov – RAS co-funding of the ISTC TI in the framework of the three years research program"Extreme Light Fields and Their Applications".
ED-CP-035 dated on 13-10-2009

Annex V
Project proposals for the TI, preliminary agreed between Partners

1. Large-Aperture Nonlinear Optical Elements for Super High-Power Laser Complexes Using High-Rate Growth of KDP Crystals

Project Manager: Prof. Alexander Sergeev
Leading Institute: Russian Academy of Sciences / Institute of Applied Physics, N. Novgorod, Russia
Collaborators / partners: Centre Nationale de la Recherche Avancée(CNRS) / Laboratoire d'Optique Appliquèe (LOA) ENSTA - Ecole Polytechnique, France (Prof. G. Mourou)
Rutherford Technology Laboratory, Didcot, UK (Prof. John.Collier)
University of Dusseldorf, Germany (Prof. O. Willi)

Estimated costs: $1,500,000

Project Summary
A technique of high-rate growth of water soluble KDP crystals of the needed orientation for further fabrication of frequency conversion elements and broadband parametric amplification for super high-power laser systems was elaborated at IAP RAS. Consumers of such nonlinear optical elements are super high-power laser complexes intended for solution of global tasks (for example, CNF, generation of superintense electromagnetic fields). These complexes have a national status (LMJ, NIF) or multi-national one, for example, the HiPER, ELI, PHELIX projects. From the Russian side consumers of our elements are the Russian Academy of Sciences and Russian Federal Nuclear Center.

The project is aimed at the construction of a complex of clean manufacturing facilities for growing, finishing, as well as protective and antireflecting coating of elements at IAP RAS. It is a Factory of Large-Aperture Nonlinear Optical Elements for Super High-Power Laser Complexes Using High-Rate Growth of KDP Crystals. The expected capability of the complex is to be 50 elements a year.

The total cost of the project, including manufacturing a pilot batch of 5 elements ~ 300x300x15 mm in size is assessed to be about 1 M Euros.

When launched with full capacity, the facility will provide free of charge European laser projects with required broad-aperture nonlinear optical crystals for the value equivalent to the European contribution to the project.

2. Study of fundamental bottlenecks of a prototype of 10 Petawatt laser facilities

Project Manager: Prof. Alexander Sergeev
Leading Institute: Russian Academy of Sciences / Institute of Applied Physics, N. Novgorod, Russia

Collaborators / partners: Centre Nationale de la Recherche Avancée(CNRS) / Laboratoire d'Optique Appliquèe (LOA) ENSTA - Ecole Polytechnique, France (Prof. G. Mourou)
Rutherford Technology Laboratory, Didcot, UK (Prof. John.Collier)
University of Dusseldorf, Germany (Prof. O. Willi)

Estimated costs: $1,500,000

Project Summary
The main aim of the project is to solve key fundamental problem limiting further power scale-up to 10 PW laser power:

- creating efficient lasers for pumping optical parametrical and Ti:sapphire amplifiers,
- suppression of parasitic nonlinear effects in laser glass and crystals,
- precise synchronization of pump and femtosecond lasers,
- increase temporal contrast ratio of the output pulses,
- increase of repetition rate of the output pulses.

These results will be useful for any petawatt and multi-petawatt lasers. Newly developed method may be used as final solutions; created devices may be used as tested prototypes of key units. Moreover, the obtained results may be used in existing petawatt lasers in order to improve their characteristics and simplify their design. It will make possible to experimentally investigate highly nonlinear processes in atomic, molecular, plasma, and solid-state physics and to access previously unexplored state of matter in many academicals laboratories.

3. Experimental and simulation-theoretical study of high-energy particle generation with short intense laser pulses

Project Manager: Dr. Sergey Belkov
Leading Institute: Russian Federal Nuclear Centre – All-Russian Scientific Research Institute of Experimental Physics, RFNC-VNIIEF, Sarov, Russia
Collaborators / partners: Laboratoire pour l'utilisation des lasers intenses, LULI, Ecole Polytechnique, Palaiseau, France (Prof. Christine Labaune)
Institute Lasers and Plasmas-CNRS-CEA-Ecole Polytechnique-University, Bordeaux1, France (Prof. Vladimir Tikhonchuk)

Estimated costs: $400,000

Project Summary
In the last years high power ultra-short lasers have been created in many scientific laboratories of the world. These lasers can produce laser intensity of up to 10^{22} W/cm^2 at the target and can be used in many fields of fundamental studies, such as acceleration physics, plasma physics of high density of energy, astrophysics, and application in medicine, material properties, diagnostics and so on. In this connection laser acceleration of electrons or ions up to energy of 1 to 100 MeV has the greatest interest.

The main goal of these studies is to receive source of high energy and quality particle beams with efficiency of conversion of energy of laser pulse into energy of the beam at the level of 10-20%.

The objective of the project is numerical calculation optimization of both the target parameters and conditions of its irradiation by ultra-short laser pulse to achieve the needed characteristics of the proton beam and experimental verification of the simulation results.

To analyze the physical processes occurring during particle acceleration, special mathematical codes will be used. These are 2D PIC codes PLASMA-2 and KARAT in RFNC-VNIIEF, 3D MANDOR code in Lebedev Institute. In RFNC-VNIITF there are 2D hybrid code PICNIC, molecular dynamic code MOLOH and HANDRA code to simulate beam propagation through the material with the account of nuclear reactions.

The Project will imply further improvements of these codes, which will ensure solution of problems of optimization of parameters of thin metal targets that will be used in experiments with FEMTO laser facility at RFNV-VNIIEF. Investigations of the perspective target-aerogel with interstice sizes of 10-50 nm will be performed too. The use of this aerogel provides an opportunity of smoothing the non-uniformities of laser intensity and increases absorption of laser pulse.

To perform experimental testing of theoretical and simulation results and physical models there is a FEMTO laser facility at RFNC-VNIIEF. It is a petawatt laser facility, based on the use of a method of parametric amplification of chirped laser pulses in DKDP crystals. The laser power achieves Pout≈1 PW with the pulse energy of about 50 J and pulse duration of about 45 fs. Laser intensity of about 10^{21} W/cm^2 can be obtained on the target.

4. Development of diagnostics for ion beams parameters measurement and their adaptation for PETAL facility

Project Manager: Dr. Anatoly Potapov
Leading Institute: Russian Federal Nuclear Centre – All-Russian Scientific Research Institute of Technical Physics, RFNC-VNIITF, Snezhinsk, Russia
Collaborators / partners CELIA-University, Bordeaux1, France (Dr. Sebastien Hulin)
Institute Lasers and Plasmas-CNRS, Bordeaux1, France (Dr. Henry Hutchinson)
Institut Lasers et Plasmas,

Estimated costs: $600,000

Project Summary
Development of a proton streak-camera, Thomson mass-spectrometer, polar-interferometer. Testing experiments at SOKOL-P ultrashort laser facility. Adaptation of these diagnostics to PETAL facility.