

## I. COVER SHEET

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*Project title:* **“THE REGIONAL TRAINING CENTER IN THEORETICAL PHYSICS”**

*Amount requested:* --- **340,700 EU.**

*Project duration:* **30 months**

*Recipient of the grant:* **Prof. Dr. Ulf-G. Meißner**  
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## II. THE PROPOSAL

### Abstract

After the demise of the Soviet Union, scientific contacts between newly independent states have been reduced. This has also affected the quality of the education: small countries can not offer the training in many different fields at the level that meets international standards. Without such a training, the students that graduate from the regional Universities are not competitive on the international job market.

The key idea behind our project is to overcome the difficulties, which emerged as a result of the disappearance of the common scientific and educational space, by establishing regional cooperation. Namely, we propose to create the joint **Regional Training Center in Theoretical Physics for young academics** (referred hereafter as “Center”) with the participation of I. Javakhishvili Tbilisi State University (TSU) and Yerevan State University (YSU). Each regional University can offer high-level training in a limited number of disciplines. **In a joint effort, the offer for the high-level training of the PhD students can be substantially enlarged.**

The regional cooperation is good for other reasons as well. For example, we plan to develop a joint curriculum that meets international standards in the pertinent fields. This will facilitate the mobility of students and the scientific staff at least within the region. Social and political aspects of such a regional cooperation are very important.

We plan to widely implement the distant teaching strategy, which allows to transmit video lectures, seminars, etc. through the Internet. Using this strategy, not only the scientific staff of TSU and YSU, but their colleagues, who do not reside neither in Armenia nor in Georgia, can get involved in the realization of the project. **In this manner, our project is set to profit from the high potential of the large Armenian and Georgian scientific diasporas, who is working in the leading Universities worldwide.** It is worth noting that the same concept has been successfully applied within the framework of the Georgian Virtual Institute of Physics that has been functioning for more than two years already, thanks to the invaluable technical assistance from the US-Georgian Educational Advising Center “Kvali,”(see <http://www.hepi.edu.ge/en/virtual.shtml> for more information about this project).

At this stage, we limit ourselves to the joint PhD courses between TSU and YSU. **We however anticipate a voluntary participation of master students of TSU and YSU, as well as PhD and master students from other Armenian and Georgian Universities.**

**The whole project is administered and supervised by HISKP, University of Bonn. This guarantees that the quality of training offered at the Center meets international standards. Note that the University of Bonn already has the experience in the organization of the Bonn-Cologne Graduate School in Physics and Astronomy that will be helpful for organizing the Center.**

In particular, the following activities are foreseen:

- Organizing joint PhD lecture courses at TSU and YSU. This envisages both the lecturer/student mobility and distant teaching (through the Internet).
- Lecture courses read at the Center by the scientists from the University of Bonn, as well as the Georgian and Armenian scientists who permanently reside outside the region. Again, this can be a combination of intensive courses (2-3 weeks), held either at TSU or YSU, and a course read at the distance.
- Joint supervision of the PhD theses by the scientists from TSU/YSU/HISKP.

- Organization of an annual joint scientific workshop and summer school for master/PhD students in Georgia or Armenia.
- Organization of short visits of Georgian and Armenian PhD students to the University of Bonn and, possibly, to other German Universities.
- Use the capabilities of the integrated TSU and YSU grid clusters during the work on the PhD theses.

Initial project duration is 30 months. We envisage that the Center will become fully functioning by the end of this period.

## Project Description.

# ESTABLISHMENT OF THE “REGIONAL TRAINING CENTER IN THEORETICAL PHYSICS” ON THE FACULTY OF EXACT AND NATURAL SCIENCES (PHYSICS DIVISION) OF THE TBILISI STATE UNIVERSITY AND FACULTY OF PHYSICS OF THE YEREVAN STATE UNIVERSITY

## Statement of need, background and Justification.

After the demise of the Soviet Union, scientific contacts between newly independent states have been vastly reduced and the integrated educational system has been fallen apart. This has affected the quality of education in these states in various ways. For instance, prior to the demise of the common state, unified evaluation criteria were applied at each level of education. Consequently, it was relatively easy for the students to choose a University, or to move to another University. After 1991, the unified criteria have ceased to exist and the mobility has been reduced. The small states, which emerged after the fall of the Soviet Union, were most affected by severing the ties. In the absence of real competition and a wide offer of training in different scientific disciplines, the quality of education in many newly independent states has been significantly worsened. This fact, together with the continuing brain drain, has already lead to a sharp decrease in the number of the young academics and, in the long run, endangers the perspectives of the sustainable development for these states.

It is clear that the above problem can be solved only through a coherent policy of respective states and national governments that implies a concentrated effort at all levels of primary, secondary and higher education. The project which is proposed below, does not aim at such an ambitious goal. It may become an important element of such a policy, if the latter is implemented in the future. At the present stage, the project may function in an autonomous regime.

The key idea behind our project is to overcome the difficulties, which emerged in result of the disappearance of the common scientific and educational space, by establishing regional cooperation. In the present situation, the national Universities in our region can offer an internationally competitive education and research only in very limited number of disciplines. By establishing the Regional Training Center in Theoretical Physics for young academics (the "Center"), we wish to re-vitalize the common space at least at the regional scale and in the selected number of disciplines.

The choice of the disciplines which will be taught at the Center was made according to the following considerations. In the USSR, theoretical high energy physics, mathematical physics and molecular biophysics have been prioritized. At present, the scientists working in these fields still remain competitive at the international level. The biggest problem is the lack of human resource, both due to the brain drain and to a relatively low number of young academics. We believe that, among other profits, bringing together the above disciplines under a common umbrella will emphasize the **interdisciplinary character** of the PhD training offered at the Center and will positively affect the quality of such a training. Besides this, the scientists with an ability to conduct interdisciplinary research will eventually have better chances at the local and international labor market.

What can the Georgian and Armenian sides offer to the Center and how do they intend to profit from it?

Both Georgia and Armenia have recently introduced the multi-level higher education system. The rationale behind this decision was to match the international educational standard. It was expected, in particular, that the introduction of the multi-level system would increase the student mobility, as well as the competitiveness of our graduates at the international labor market.

Both TSU and YSU are among the leading Universities in their respective countries and enjoy a high reputation in the society. Their graduates enjoy advantages at local labor markets. We would like to emphasize that, apart from fundamental investigations; the Faculties of the Natural Sciences of TSU and the Physics Faculty of YSU carry out applied studies that have direct impact on the economics of their countries. For example, the Physics Faculty of YSU develops information technologies and carries out investigations of the banking and finance sector, while TSU entertains its leadership in applied electrodynamics and computer simulation of ED processes.

Both TSU and YSU offer the bachelor and, to a large extent, master training that generally meets international standards. The courses offered and the curricula are compatible with the ones at the leading Universities worldwide, and the quality of tuition is, as a rule, good.

At the same time it is necessary to mention that the system of the post-graduate education at both TSY and YSU is far from optimal. The same statement applies to almost the whole post-Soviet space, since the problem is inherited from the Soviet past. Namely, PhD students are supposed to work on their doctoral theses and pass the exams (and for these exams they are supposed to prepare in an autonomous regime). No special PhD courses are offered. So, the education of a young academic actually ceases after he/she obtains the master degree. It is clear that the PhD training of this quality cannot represent a viable alternative to doing a PhD thesis in the leading Universities worldwide. It does not therefore come at a surprise that the overwhelming majority of the PhD students prefer to leave Georgia and Armenia and work on their thesis at these Universities. Thus, the “brain drain” at this level includes almost 100 % of all graduates that have decided to continue the scientific career.

In order to make our post-graduate education a) attractive for the graduates of local Universities and b) globally competitive, we propose to fundamentally overhaul the existing post-graduate training system. The proposed establishment of the Center serves exactly this purpose. It is planned that the Center will provide the PhD students with additional courses on wide-ranging subjects and the quality of these courses will be judged according to the strict excellence criteria. In order to achieve exactly this goal, we need a regional cooperation and the expertise of our colleagues from different Universities in certain fields.

We wish to stress that the Center will be offering an **interdisciplinary training**. Apart from helping to prepare the specialists with a wide profile, we believe that this will enable one to address the problem of a relatively small number of potential PhD candidates in natural sciences (at least, at the starting phase of the project).

In our opinion, the perspective and availability of obtaining a **wide-ranging post-doctoral education at the level of excellence** from the well-known experts in the field can serve as an incentive for the potential PhD candidates and thus slow down the process of the “brain drain.”

The Center will be jointly created by TSU and YSU. Moreover, it is expected that the former scientific staff of these Universities, which is presently employed at the Universities and research centers around the world, will actively participate the work of the Center. In this manner, the large potential of the regional scientific diaspora will be also used. Furthermore, the Center is open for new regional participants who are interested to join.

The project will be supervised and managed by the University of Bonn, which has its own experience in participating the Cologne-Bonn Graduate School in Physics and Astronomy (BCGS, see <http://www.gradschool.physics.uni-bonn.de>). It is planned that the University of Bonn will contribute to the following activities of the Center:

- The University of Bonn will offer expert opinion on the suggested lecture courses. It will also formulate proposals for holding particular lecture courses.

- The staff of the Bonn group will take part in the lecturing process (via Internet) on the voluntary basis.
- The students at Georgian/Armenian Universities will be given an opportunity to participate student's seminars at HISKP, University of Bonn, through Internet.
- The staff of the Bonn group will take part in supervision of the MS and PhD students via Internet. The best students can be given an opportunity to work on their thesis at the University of Bonn.
- Within the project, short visits of Georgian/Armenian scientists at the University of Bonn are planned. During these visits, the members of TSU/YSU groups will closely observe teaching process and get full information about the tuition standards at the University of Bonn.

Last but not least, we wish to mention that, apart from apparent scientific and educational merits, the project will have important social and political implications. We believe that the implementation of any cooperation project in our region contributes to regional stability, which is the key precondition for the development.

If the project is implemented successfully, in the future one may consider transforming the Center into a full-fledged regional graduate school Tbilisi-Yerevan with 2 years of master studies + 3 years of the PhD studies.

### **Management of the project**

As mentioned above and overall management of the project is done by the Faculty of Exact and Natural Sciences, University of Bonn. The coordinator of the project is Prof. Dr. Ulf-G. Meißner.

At the regional level, Faculty of Exact and Natural Sciences (Physics Division) of TSU and Physics Faculty of YSU create working groups that manage the project. The working group elects its manager, who administers the work of the group and regularly reports to the coordinator of the project. The manager of the YSU group is Armen Nersesian. The manager of the TSU group is Mirian Tabidze.

The space and basic infrastructure necessary to carry out the teaching process will be provided by the faculties/institutes.

The working groups, in cooperation with the University of Bonn, are responsible for creating the joint curriculum for the planned PhD courses, as well as for preparing and carrying out these courses. University of Bonn offers the prior expert evaluation of the lecture courses delivered at the Center.

TSU and YSU working groups, with the consent of the coordinator of the project, may offer the participation to the external scientists which are not employed either by TSU or YSU. For example, the lecture courses may be delivered by the scientists working at other Georgian/Armenian Universities, or the representatives of the Georgian/Armenian scientific diaspora.

### **Activities of the Center**

The planned activities of the Center, in particular, include:

- Organization of the joint lecture courses for the students of TSU and YSU, as well as from other Georgian/Armenian Universities. According to our experience, the most optimal strategy consists in the following:
  - 1) Holding **intensive lecture courses** (2 weeks, 3-4 lectures/exercises per week) 1-2 times per semester in the presence of all students and a lecturer, either at TSU or YSU.
  - 2) Holding the rest of a lecture course, using **web transmission**. Our experience shows that it is useful to assign **assistant lecturers** who are be present “at the other end of a wire” and help to moderate discussions. For example, if a lecturer from TSU reads a lecture through Internet, an assistant lecturer will be present, together with the Armenian students, in the lecture hall of YSU.
  - 3) Written/oral exams can be performed either in the presence of a lecturer, or through the Internet.
- The same procedure is at work, if the lecture is read by an “**outside**” lecturer, e.g., the representatives of the Georgian/Armenian scientific diaspora.
- **Joint supervision of the PhD theses** by the scientists from TSU/YSU/HISKP. This envisages the organization of the short-term student visits to the respective Universities, as well as permanent contacts though the Internet.
- Organization of the TSU/YSU/HISKP annual workshops in theoretical physics/theoretical biophysics, combined with the summer school for PhD and master students from Georgian/Armenian Universities. A large representation of the Georgian/Armenian scientific diaspora is foreseen.
- Organization of the work of grid clusters in Tbilisi and Yerevan

### Distant teaching

In the teaching process, we plan to actively use e-learning tools (distant teaching), which have been successfully implemented in another, already running project "**Georgian Virtual Institute of Physics**," (see the web-page of the project <http://www.hepi.edu.ge/en/virtual.shtml> for more information). To this end we shall need to equip the classes by modern communication means, allowing to organize video conferences and distant teaching. At YSU, at the first stage, an existing infrastructure of the **University Center of Excellence (UCE) "Algebraic and Geometric Studies for Condensed Matter Physics"** at the Chair of the Theoretical Physics and the scientific laboratory of the Physics of Macromolecules can be used. At TSU, at the first stage, one can use the existing infrastructure of the **Educational Training Center “Kvali,”** whose leadership has kindly offered support to the project.

It should be also pointed out that distant teaching (transmitting lectures from Bonn to Cologne and vice versa) is widely practiced in Bonn-Cologne Graduate School in Physics and Astronomy already for years now. Moreover, recently the distant lecture course on effective field theories and lattice field theory (lecturer: Prof. D. Lee) was organized between HISKP, University of Bonn and Ruhr University of Bochum.

**A tentative list of the suggested lecture courses:**

*12-15 lectures will be selected from this list. Additional courses can be also considered. The budget is planned in the assumption that 14 courses will be held.*

1. *Quantum Mechanics and Quantum Field Theory on the Lattice*, by Akaki Rusetsky (Bonn) and Mirian Tabidze (TSU).
2. *The Methods of the Quantum Field Theory: Particle Physics of Standard Model and Beyond; Intersection with Cosmology*, by Zurab Tavartkiladze (Ilia State University, Tbilisi) and Gela Devidze (HEPI of TSU).
3. *Gravitation, Cosmology and Astropartical Physics*, by Merab Gogberashvili (TSU).
4. *Advanced Mathematical Methods in Physics*, by Armen Nersessian (YSU), Merab Eliashvili (TSU) and Merab Gogberashvili (TSU).
5. *Physical Applications of Group Theory*, by Anzor Khelasvili (HEPI of TSU), George Jorjadze (RMI, TSU) and Tigran Hakobyan (YSU).
6. *Computational methods in modeling of Physical Processes*, by Mirian Tabidze (TSU) and Tigran Hakobyan (YSU) .
7. *The methods of Quantum Chromodynamics and Effective Field Theory*, by Akaki Rusetsky (Bonn) and Anzor Khelasvili (HEPI of TSU).
8. *Topological Objects*, by Armen Nersessian, Gor Sarkissian (YSU) and Merab Gogberashvili (TSU ).
9. *Statistical Physics and Thermodynamics of Macromolecules*, by Yevgeny Mamasakhlisov (YSU).
10. *Advanced course on Critical Phenomena: Introduction to Renormalization Group and Scaling in complex systems*, by Vadim Ohanyan (YSU).
11. *Molecular Biophysics*, by Vladimir Morozov (YSU) and Tamaz Mdzinarashvili (TSU).
12. *Introduction to Integrable Systems in Statistical Mechanics with application to quantum field theory and polymer systems*, by Vadim Ohanyan and Tigran Hakobyan (YSU).
13. *Quantum Fields and Low Dimensional Physical Systems*, by Merab Eliashvili (TSU) and Gor Sarkissian (YSU).
14. *Advanced course on Quantum Magnetism*, by Tigran Hakobyan and Vadim Ohanyan (YSU).
15. *String theory and conformal field theories*, by Gor Sarkissian (YSU) and Mirian Tsulaia (Ilia University, Tbilisi).
16. *AdS/CFT Correspondence*, by George Jorjadze (RMI, TSU)
17. *Radiation and propagation of electromagnetic waves in randomly inhomogeneous media*, by Zhirayr Gevorkian (YSU & Institute of Radiophysics and Electronics of the Armenian Academy of Science)

## Expected results

The project has a great practical importance not only for graduates of the TSU and YSU, but also for the educational system of the whole region. As mentioned above, it may help slowing down the brain drain in the South Caucasus, offering opportunities of the excellent training in certain disciplines and fields. On the other hand, the implementation of the project will foster links between various Universities in the South Caucasus, which will be able to more effectively exchange their knowledge, research methods etc. The research and the level of education in these Universities are set to greatly profit from the existence of such links.

Initial duration of the project is 30 months, from which the initial 6 months will be dedicated to the preparatory work. It is planned that, at the end of this period, the Center will be completely functioning. The normal functioning of the Center implies, in particular, that:

- The working groups will provide the interaction and coordination between the Faculties, monitoring all stages of the teaching process and overseeing the rational use of the finances.
- Joint curricula in various fields of theoretical physics will be established. The publication of the lectures delivered at the Center, as well as the methodological literature is also planned.
- One video conference room in both TSU and YSU will be completely equipped.
- The project web site will be created.
- The joint lecture courses will be delivered. These imply both the lectures delivered at the distance (through the Internet) and organization of the short intensive courses, which will be delivered by visiting scientists.
- The regional schools/conferences for the students of TSU and YSU will be organized on the yearly basis.
- Exchanges of the scientific personnel and the PhD students, participating the work of the Center, between Tbilisi and Yerevan will take place on the regular basis.
- Joint supervision of the Master and PhD theses will be offered.
- Integrated grid clusters of TSU and YSU will be used for the solution of physical problems.

The success of any education project is eventually determined by the interest to this particular form of education among the potential recipients of education. At the present time, the priority to the educational reform ranks high in our societies. Thus, in our opinion, the project **“REGIONAL TRAINING CENTER IN THEORETICAL PHYSICS”** has good chances to succeed.

## TSU and YSU Team Descriptions

The YSU team consists of four research staff members: Armen Nersessian, Vadim Ohanyan, Gor Sarkissian, Yevgeni Mamasakhlisov and one administrative staff member / webmaster Gayane Karapetayn. The field of expertise of the team members includes the methods of statistical physics, bioinformatics, geometric methods of the study of the exactly solvable models of classical and quantum mechanics, noncommutative mechanics, supersymmetric mechanics, quantum magnetism, integrable models in statistical mechanics, physics of macromolecules and structural biology.

The TSU team consists of five research staff members: Mirian Tabidze, Merab Eliashvili, Tamaz Mdzinarashvili, Merab Gogberashvili and Anzor Khelashvili. The team members are experts in quantum field theory and quantum statistics, mathematical physics, QCD at low energy, supersymmetric models, alternative models of gravity, topological objects, dark matter and dark energy, low dimensional condensed matter systems, extra dimensional models, hydro- and thermodynamic properties of proteins, computational methods and modeling in physics.

The members of both teams are active scientists with a strong research background and with a large experience in teaching various advanced as well as undergraduate courses in physics. They annually advise master and PhD theses, as well as involve the master / postgraduate students into their research. Many team members from TSU and YSU know each other for a long time. Note, for example, that Yevgeni Mamasakhlisov got his PhD degree in Tbilisi Institute of Physics, while one of the lecturers from Georgian group, Mirian Tsulaia, has begun his research work in collaboration with Armen Nersessian. For the successful realization of the project, the (already) existing scientific contacts between the different team members will play an important role. Moreover, it is expected that the Georgian team will shortly join the acting ICTP regional network Armenia-Iran-Morocco-Turkey, headed by Armenia.

### The YSU team:

The research of **Armen Nersessian** is mainly focused on the application of the methods of differential geometry to the mechanical models, which are being investigated in quantum field theory and condensed matter physics. This, in particular, includes studies of the supersymmetric and noncommutative mechanics interacting with gauge fields, of various generalizations of the Landau problem, and of the Coulomb and oscillator systems. Note that Armen Nersessian was among the first to study the geometry of the Lagrangian quantization schemes (BV-formalism). His research interests include the application of Hopf maps to the various problems of supersymmetric mechanics and Hamiltonian reduction. At the end of nineties, on the basis of Frenet formulas, he developed a geometric approach to the Hamiltonian formulation of the particle systems with the Lagrangians depending on extrinsic curvatures. In the recent work with Mamasakhlisov, these methods were applied to the problems of dynamics of a worm-like polymer chain. Armen Nersessian has been an adviser of few bachelor, master and PhD theses. Last but not least, one should mention his essential contribution to the organization of the YSU team.

The research of **Yevgeni Mamasakhlisov** is essentially focused on the application of the methods of equilibrium and non-equilibrium statistical physics to the study of the structure and dynamics of the biological molecules. In particular, his investigations cover the double-stranded DNA pulling, the protein and single-stranded RNA folding, the non-equilibrium features of Coulomb systems, statistical mechanics of the Potts model, melting of the biological macromolecules, etc. Recently, he proposed an approach to the double-stranded DNA pulling problem, based on the Zimm-Bragg model. It was shown that the chain heterogeneity can play the crucial role in the process of condensation. Along with other colleagues, he pioneered the application of the Potts-like models to problems of the helix-coil transition in the proteins and DNA. Yevgeni Mamasakhlisov has a twenty years long teaching experience. In the recent years, he taught the courses "Physics of the Condensed State of Macromolecules" for the 4th year bachelor students, "Introduction to the Non-Equilibrium Thermodynamics" for 1st year master students, and "Physics of the Biological and Synthetic Polymers" for the 2nd year master students.

**Vadim Ohanyan** is an expert in the field of integrable systems, in the statistical mechanics and field theory and in the quantum magnetism. He was among the first to find exact solutions to the lattice spin models with Ising and Heisenberg bonds. These theoretical solutions have recently found an experimental implementation in the class of novel coordination polymer compounds. In his research, Vadim Ohanyan combines the methods of integrable models with the theory of magnetism, searching for the exactly solvable models which can serve as an approximation for the real magnetic materials and other strongly correlated systems. In particular, he investigated the exact description of the magnetocaloric effect in  $S=1/2$  XXZ chain. At present, together with the collaborators from Germany and Ukraine, he continues the research of the magnetocaloric properties of the spin chains by using the fermionization method. In addition, he has carried out investigations of the integrable models of mechanics with magnetic monopoles in collaboration with Armen Nersessian, as well as the collaborators from Russia and Italy. Vadim Ohanian has an eleven year long teaching experience at the Yerevan State University and at the Russian-Armenian University. In the recent years he delivered advanced courses "Phase Transitions and Critical Phenomena," "Introduction to the Bethe-ansatz," "Introduction to the Statistical Mechanics for Biophysicists" and several standard undergraduate courses.

**Gor Sarkissian** has a broad expertise in various aspects of string theory and conformal field theory. He got his PhD degree at Hebrew University in Jerusalem. Then, he moved to the postdoc positions at ICTP, at the Department of Mathematical Sciences of the University of Aarhus, at the University of Rome "Tor Vergata" and INFN section Rome "Tor Vergata," and at the Department of Mathematics of the University of Hamburg. The description of the non-linear sigma-models with defects and boundaries belongs to the main scientific achievements of Gor Sarkissian. In particular, we mention the study of the defects in the  $SL(2,R)$  WZW model by using cluster conditions, the connection between the string T-duality and the defects of world-sheet, and the relation between the quantized Teichmüller space and the Liouville field theory beyond the closed world-sheet with defects and boundaries. Gor Sarkissian has teaching experience at Hebrew University and at the Aarhus University, where he has delivered a postgraduate course "Higgs Bundles and the Geometric Langlands Program."

Administrative staff member **Gayane Karapetyan** has a firm experience of coordination and administrative work. For two years now, she works as a head of the Department of Grants of the administration of Yerevan State University. She has PhD degree in experimental nuclear physics, and she is a researcher at the Department of Nuclear Physics of YSU. Her field of expertise includes data analysis in nuclear physics experiments.

#### The TSU team:

The TSU group manager **Mirian Tabidze** is an expert in the experimental high energy physics. His main fields of interests include spectroscopy, correlation phenomena, CP-physics and spin physics. During the several years he was an active member of various international collaborations: MIRABELLE and GAMS (Serpukhov, Russia); EHS-NA22, DELPHI and ALICE (CERN, Swiss), KLOE (Frascati, Italy). At this moment, he is a leader of the Georgian group at the Polarized Antiproton Experiment (PAX) collaboration. Recently, his interests were focused on the simulation studies for the spin filtering experiments at COSY and AD-CERN which were aimed at designing and optimizing a common detector to measure the polarization observables in  $pp$  and  $pp$ -bar elastic scattering. Another fields of his research interests are the study of spin structure of the NN-amplitudes, and the study of the deuteron breakup at low energies as a probe for the Chiral Effective Field Theory predictions. Mirian Tabidze has supervised two master and one PhD theses. Since 2007, as a Head of Laboratory in TSU, he teaches master course "Modeling and Data Analysis in High Energy Physics".

**Merab Eliashvili** is an expert in the area of quantum field theory, with applications to elementary particle physics and condensed matter physics. His investigations cover nonlinear realizations of chiral symmetry, quantization of constrained systems, supersymmetric models, temperature behavior of spontaneously broken symmetries, construction of effective potentials in quantum field theory and quantum statistics. In the last period, his interests are focused on the applications of quantum field theory

and geometric methods to the problems of low-dimensional condensed matter systems, like quantum Hall effects and anyon superconductivity. He was one of the first to apply the non-commutative geometry methods to the studies of quantum Hall liquid. At present, his studies are concentrated on the problem of graphene in the magnetic field. many years M. Eliashvili is lecturing at Tbilisi State University, delivering various courses in theoretical and mathematical physics. He has been an adviser for several bachelor, master and PhD theses.

**Tamaz Mdzinarashvili** is a full professor at TSU. He is an author of several master and doctorates programs at the Faculty of Exact and Natural Sciences. At present, he is a leader of the biophysical program at the Faculty and he is a director of the Medical and Applied Biophysics Institute at TSU. His research interests include the investigation of the hydrodynamic, thermodynamic and spectrophotometric properties of proteins, DNA, drug delivery nanoparticles (liposomes, PLGA type) and bacterial viruses (bacteriophages) as well.

**Merab Gogberashvili** is known as one of the pioneers who have investigated the non-compact extra dimension models and most of his papers are devoted to the brane models. However, his interests are broader and include: field theory (extra dimensional models, properties of elementary particles); gravity (alternative models of gravity, topological objects, gravitational waves); cosmology (dark matter and dark energy, baryon asymmetry); quantum mechanics (connections with classical statistical mechanics); mathematical physics (normed algebras). He has a six year long experience of teaching various theoretical courses at TSU.

**Anzor Khelashvili** is one of the most experienced member of the TSU team and has a wide-ranging expertise in quantum field theory and elementary particle physics. His past research, starting from the early sixties of the last century includes, in particular: the quasipotential approach for spin  $\frac{1}{2}$  particles, both instantaneous and light-front formulations; integral equations for three-body systems, known as AGSK formulation; mechanisms of chiral symmetry breaking; current algebra and symmetries; various sum rules for weak decay form-factors; infrared behavior of the gluon propagator in QCD and phenomenological potentials between quarks; deep inelastic processes; hidden dynamical symmetries in relativistic quantum mechanics; singular potentials and problems of self-adjoint extensions; renormalization and regularization problems in quantum field theoretic models. He has taught more than 30 different bachelor and master courses in general and theoretical physics at TSU during 1966-2010, and he has supervised more than 30 master theses, and 10 PhD theses. He is author of four monographs in theoretical and high-energy physics.

### **Bonn team description**

The theory group at HISKP, University of Bonn is one of the largest and well-known centers in the world for study of QCD at low energy. Its expertise covers wide range of issues from first principle calculations on the basis of lattice QCD and effective field theories to quark models. The theory group of the Institute for Physics of the University of Bonn is known for the first-class research work carried out in the fields of high-energy elementary particle physics, supersymmetry and string physics, condensed matter physics. It should be pointed out that, in addition to the scientific research, both theory groups are actively involved in training of young academics: a large number of MS and PhD students both from Germany and abroad are completing their theses here every year.

**Ulf-G. Meißner** is one of the world leading experts in low-energy effective field theories of QCD and has worked in the field already for decades. His research interests, in particular, include baryon Chiral Perturbation Theory, effective field theory for nuclear forces and nuclei, photo-nucleon and photo-nuclear physics, baryon form factors, nuclear lattice simulations, resonances on the lattice, hadronic atoms, etc. He

has pioneered groundbreaking investigations in many of these and other fields. During his scientific career, he has supervised around 40 MS/PhD students.

It should be pointed out that, along with the active research work, Ulf-G. Meißner performs many administrative duties. In particular, he is a dean of the Faculty of Natural Sciences at the University of Bonn and the director at the Institut für Kernphysik at the Forschungszentrum Jülich (IKP-3, Theoretical Nuclear Physics).

**Akaki Rusetsky** has been working in low energy effective field theories of QCD in the larger part of his scientific career. He is an expert in low-energy interactions of mesons and baryons, electromagnetic processes and isospin breaking, hadronic atoms, effective field theories in a finite volume and studying the resonances in lattice QCD. He is actively involved in the teaching process, and has supervised the work of several MS and PhD students.

Akaki Rusetsky graduated and got his PhD degree from Tbilisi State University. He maintains close contacts with the Georgian colleagues, is involved in research projects with them, and takes an active part in the work of the Georgian Virtual Institute of Physics.

### Students

The number of the students in the Center is a crucial factor. If that number is too low, the Center is not sustainable and the project can not succeed.

Below, we give an initial estimate of the Georgian and Armenian students, who are expected to take part in the work of the center, as well as discuss the financial aspects of their study. We expect that, once the Center is established and it becomes clear that it provides a well defined career track for the young researchers who participate its work, the number of those researchers will rapidly increase in the following years.

The situation on Georgia and Armenia is rather different with respect to the students. Below, we consider them separately.

In Armenia, almost all PhD students in Physics/Mathematics get a moderate salary (around 60 Euro/month) from the State. Besides this, all Ms and PhD students of the Yerevan Physics Institute (YerPhI) get a support (around 80 Euro/month) from the Institute. Further, the regulations of Armenian Committee of Sciences requires the presence of students in all scientific proposals, supported by government. The same regulations are valid for ANSEF (Armenian National Science and Education Foundation, based in New York). This means that Ms and PhD students, working under the supervision of active researchers, earn additionally 80-200 Euro/month. Finally, there are special programs for Ms and PhD students of the State Committee of Science and of the NFSAT (National Foundation of Science and Advanced Technology, sponsored by CRDF).

Each year, about 100 students get the Bachelor degree at the faculty of Physics of the Yerevan State University. About 50 students take the Master courses. This year, there are 50 second-year and 43 first-year Ms students at YSU. Approximately half of them will defend his/her Ms thesis in the field of theoretical physics. Moreover, about 20 students defend Ms theses at the Faculty of Radiophysics of YSU. Some of them may be interested to attend the lectures of the Center. In addition, there are 7 second-year and 8 first-year Ms students at the faculty of Physics and Technology of the Russian-Armenian University. All of them are defending their Ms theses in the theoretical solid-state physics (physics of semiconductors).

Currently, there are 30 PhD Students ( first-, second- and third year) at the Physics Faculty of YSU. Among them, 20 students work in different areas of the Theoretical Physics.

In addition, there are:

3 PhD students in theoretical physics at the Russian-Armenian University,  
5 PhD Students at the Theory Department of the Yerevan Physics Institute,  
3 PhD Students in theoretical physics at the Institute of Physical research of the Armenian Academy of Science,

Besides this, there are PhD Students, specializing in theoretical physics, in other Institutes of the Armenian Academy of Science: at the Institute of Applied Problems of Physics, Institute of Radiophysics and Electronics, Institute of Chemical Physics, etc.

So, at present there are about 35 PhD Students in Armenia, specializing in theoretical physics. Among these, there are the students which prepare/intend to prepare their PhD theses under the supervision of the members of the Armenian team at the Regional Center:

3 PhD students:

Armen Saghatelian (first-year student, adviser: A. Nersessian)  
Gor Hayrapetyan (second-year student, advisers: Ye. Mamasakhlisov and V. Morozov)  
Martiros Khurshudyan (first-year student, adviser: V. Ohanyan)

2 master students, which plan to work on their PhD theses:

Mariam Nikoghosyan (first-year Ms student, advisers: A. Nersessian and T. Hakobyan)  
Martin Charokhchyan (second-year Ms student, adviser: Y. Mamasakhlisov)

There are 2 promising last-year Bachelor students, working under the supervision of the Armenian team members:

Haik Tsaturyan (adviser: Ye. Mamasakhlisov)  
Eva Gevorkyan (adviser: A. Nersessian)

Furthermore, the following PhD students from the Department of Theoretical Physics at YSU plan to attend the courses at the Center:

Gor Abovyan (first-year student, adviser: G. Kryuchkyan)  
Vardan Baghderyan (second-year student, adviser: A. Saharian)  
Narek Hakobyan (second-year student, adviser: V. Harutyunyan)

in addition, two PhD and two Ms students of the Theory Department of YerPhI already expressed their intention to attend the PhD courses:

Levon Chakhmakhchyan (PhD student, adviser: N. Ananikyan)  
Levon Tamaryan (PhD student, adviser: S.-N. Tamaryan)  
Armen Poghosian (Ms student, adviser: Rubik Poghosian)  
Hasmik Poghosian (Ms student, adviser-Rubik Poghosian)

To summarize, we expect that, at the initial stage, about 10-15 Armenian students will attend the lectures of the Center.

**In Georgia**, the number of Bachelor/Ms students dramatically went down after 2007, in a result of the reorganization of Physics Faculty of TSU. In the last two-three years, an opposite trend is observed that in part is related to a concentrated effort to promote education in exact sciences, which was recently undertaken by the State. This, in particular, includes financial stimulus (e.g., reserving fixed number of student vacancies in physics, which are completely freed from tuition fee), and the popularization of the education in exact sciences through the media outlets. Another important factor that contributed to the above-mentioned surge, is the work of the non-governmental structures, specializing in the education (e.g., the Educational Advising Center “Kvali,” etc), as well as the inflow of the private financing into the educational sector.

The above-mentioned dynamics is well illustrated by the year-to-year dynamics of the Bachelor students with major physics at the faculty of the Exact and Natural Sciences at TSU:

2008: 23 students  
2009: 20 students  
2010: 30 students  
2011: 55 students

One should increase these numbers by approx. 10-15%, owing to the mobility.

In the recent years, the number of Ms students at TSU was around 10-15/year, and the number of PhD students around 1-2/year. The number of the Ms and PhD students still have to feel the positive trend observed for the Bachelor students.

It should be pointed out that the similar trend is observed at other Georgian Universities, not owned by the State. Namely, recently the Bachelor courses in physics were offered by Free University, Ilia University and Georgian University. An estimated number of Bachelor students here is around 20-30/year. There are number of Ms and PhD students at Ilia University and University of Patriarchy.

We expect that the positive trend that was observed in the last couple of years, will continue in the years to follow. It is important to mention also that there is a dramatic change in the qualification of the students. In particular, most of the new students regularly took part at school Olympiads in Physics/Mathematics. They are much better prepared than their colleagues which became students few years ago.

Based on the numbers given above, we estimate the number of Georgian students at the Center is around 5 at present. It is expected that this number will gradually increase in the next years. In addition, two Georgian Students which start their PhD work at HSKP, University of Bonn, will also be embedded in the framework of the Center.

The Ms and PhD students in Georgia do not get the salary from the State. At some Universities there are tuition fees which are linked to the academic grades. The students can apply for support to private foundations. Shota Rustaveli National Science Foundation, which is a State agency financing the scientific research in Georgia, gives the advantage to the projects where Ms and PhD students are included. For this reason, practically every student in Georgia is financed from a some research project.

## **Financial aspects:**

Within the present project **we do not apply for a salary for PhD and Ms students**. It is assumed that this should be done through the pertinent national agencies. We apply **to finance only the student mobility**: the exchanges between Armenia/Georgia, visits to Germany, participation at various schools/conferences.

## **Sustainability of the Center**

A central issue of the project is its sustainability after finishing the initial funding period, where a lion's share of the financial burden is carried by the VolkswagenStiftung. It is crucial that, **after the initial period, the largest part of the financial burden is born by national funding agencies**, such as:

State Committee of Science of Armenia <http://www.scs.am>

National Foundation of Science Advanced Technologies (NFSAT), <http://nfsat.am>

Armenian National Foundation of Science and Education (ANSEF), funded by diaspora <http://ansef.org>

Shota Rustaveli National Science Foundation <http://www.rustaveli.org.ge>

**Moreover, it is a general understanding between our team members that the projects like the “Regional Training Center in Theoretical Physics,” which could play an important role in the Educational Reform in Georgia and Armenia, can function only with a substantial state support.** It would be a mistake, in the long run, to rely on the overwhelming support of the international bodies.

We understand that, after the initial period, the Center will already have purchased the hardware necessary for the transmission of the lectures, and approx. 15 lecture courses will be prepared. After this period, the Center will have to pay only for the student/lecturer mobility, organization of the schools/conferences, delivery of the already prepared courses and, eventually, for some new courses that we decide to add to the curriculum. All this requires expenditures at a lesser scale than implementing the project from the beginning.

In addition to the national funding agencies, after finishing of the first funding period, we plan to submit applications to various international funding bodies (e.g., DFG, DAAD, CRDF, etc), in order to support specific items in the project. This mainly concerns the support of the student and researcher mobility: visits to Germany, participation at schools/conferences, etc.

We would like to stress: **in order to get a substantial financial support from the national funding agencies, one has to demonstrate that one is dealing with an already established and functioning body.** Therefore, at the initial stage of the implementation, we have opted to mainly rely on international funding agencies.

## **Career track**

In the long run, the project will sustain and will be internationally competitive, if it provides a well-defined career track for young researchers which attend it. The question is, what kind of a track it defines.

One of the goals of the project is to cope with the brain drain that has become a very big problem in Georgia and Armenia. The project deals with this problem by demonstrating that it is possible to obtain an internationally competitive and commonly acknowledged PhD degree **without leaving these**

**countries.** We hope that this will slow down a very early and massive outflow of the Ms and PhD students that takes place at present. On the other hand, the students' involvement in the research projects carried out by Georgian and Armenian scientists will definitely have a positive impact on the status of scientific research in these countries.

The brain drain, however, will remain a severe problem until the governments of Georgia and Armenia do not focus on the creation of the positions for the returning experienced scientists: e.g., **the relatively well-funded tenure track positions for the scientists with few years of the post-doc experience abroad.** Such positions could be attractive for quite a few young Georgian and Armenian researchers, currently working at the leading Universities worldwide, giving them a real alternative to looking for the positions in the industry.

The success of the Regional Training Center in Theoretical Physics could be a strong argument in favor of such a strategy.

### Grid clusters

At present, two grid clusters with approx. 500 Gigaflops each are functioning at TSU and YSU. These clusters are integrated into the Black Sea common network (Sea Grid). In the future, it is planned to integrate these clusters into the European network (Euro Grid) and using them for the data analysis of LHC@CERN and COSY@FZ-Juelich experiments. Note that the Georgian and Armenian scientists and PhD students are already actively involved in these experiments. Since one of the main goals of the student education at the Center is to bring the education process close to the research practice, for the students, specializing in high-energy theoretical physics, the Center plans to organize introductory courses in the high-energy experimental courses, including the experimental data analysis “at the frontier.”

We see two main areas where the existing grid clusters could be useful for the Center:

1). There exists a possibility to use these clusters for the solution of local problems, especially those which use parallel programming algorithms. These problems, in particular, include calculations in lattice QCD. Such calculations are performed at the University of Bonn (note also existing collaboration with QCDSF). It is planned that the Armenian and Georgian students, who are interested in the physics of hadrons, can **solve problems in lattice QCD** directly under the supervision from Bonn. This, on the one hand, will get these students actively involved in the investigations at the scientific frontier and, on the other hand, will allow the Center to attract the PhD and master students studying information technologies and to create new, interdisciplinary courses.

2). The proposed project includes courses about molecular biophysics, physics of macromolecules and computational modeling. Due to ever increasing data sizes and the high computational complexity of many algorithms, there is a natural drive towards applying parallel and distributed computing to **the problems of the biomolecules' simulation.** Grid computing techniques can provide flexible, portable and scalable software solutions for parallel simulations in the field and to train PhD students to carry out high level research. In particular, it is envisaged that the computational modeling will be focused on the problems of RNA and protein folding.

For the above reasons, a moderate support of the functioning of these grid clusters within the present project is planned.

### **Participation of the Georgian/Armenian diaspora**

For a successful implementation of the project, an active participation of Georgian and Armenian scientists, permanently residing outside the region, is of crucial importance. This participation should proceed in form of lecturing through internet, co-supervising PhD theses, short-term visits, participation the schools/workshops organized by the Center, etc.

We have a written agreement to participate the work of the Center from the following scientists of Georgian/Armenian origin:

1. Gregory Gabadadze (New York University, USA)
2. Jambul Gegelia (Ruhr Universität Bochum, Germany)
3. George Jackeli (Max-Planck-Institut, Stuttgart, Germany)
4. George Japaridze (Clark Atlanta University, Atlanta, Georgia, USA)
5. Ruben Minasian (IPhT, Saclay, France)
6. Emil Yuzbashyan (Rutgers University, USA)

We have contacted more scientists, and have obtained oral agreement to cooperate. The overall mood is very positive. We do not doubt that, if the project of the Center proves to be successful at the initial stage, the number of the foreign-based scientists, involved in this project, will gradually increase.

### Timetable

1-6 months	Opening of the Regional Training Center in Theoretical Physics Work on the joint curricula in theoretical disciplines Preparation of the lecture courses Creating the infrastructure for the e-learning at TSU and YSU Preparation for the integration into the Euro Grid Creating the web page of the Center
7-12 months	Work on the joint curricula in theoretical physics, expert opinion from HISKP Preparation and conduct of the lecture courses Continuation of the work on the infrastructure Integration into the Euro Grid Organization of the Workshop/Summer School at YSU or TSU
13-18 months	Preparation and conduct of the lecture courses Start of the joint supervision of the PhD students Using integrated grid clusters for the solution of the physical problems Organization of the short-term student visits
19-24 months	Preparation and conduct of the lecture courses Joint supervision of the PhD students Using integrated grid clusters for the solution of the physical problems Organization of the short-term student visits Organization of the Workshop/Summer School at TSU or YSU
24-30 months	Preparation and conduct of the lecture courses Joint supervision of the PhD students Using integrated grid clusters for the solution of the physical problems Organization of the short-term student visits

**Budget for 30 months 340,700 EU (including ~25% for the German side)**

**TBILISI/YEREVAN:**

<b>Monthly salary for 2 managers and an administrative staff member / webmaster</b>	30*(150+2*300)	<b>22500</b>
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<b>Preparation and delivering of 14 lecture courses:</b>	14*4000	<b>56000</b>
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*4000 Eur includes:*

- *Delivery by the principal lecturer  
20 Eur/hr \* 4 hr/week\* 14 weeks = approx 1100 Eur*
- *Work of the assistant lecturer  
5 Eur/hr \* 4 hr/week\* 14 weeks = approx 300 Eur*
- *Preparation of the lecture course, uploading electronic script and exercises on the web = approx. 2600 Eur, to be paid once upon the preparation of the course for the first time.*

*Note: the numbers above can vary, depending the distribution of work among the principal and assistant investigators, leaving the total sum invariant.*

<b>Equipment for the videoconference room and montage of the apparatus + an office for the invited professors (Tbilisi)</b> <i>(see below for details)</i>	10000 (Yerevan) +13000 (Tbilisi)	<b>23000</b>
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<b>Money for lecturer visits to Tbilisi/Yerevan (two weeks)</b> <i>(5 visits per semester=10 visits during 2 years)</i>	2*10*[30 (travel) +7*(80+50) <i>(Tbilisi: 50 per diem, 80 hotel)</i> +7*(30+50) <i>(Yerevan: 50 per diem, 30 guesthouse, special price)]</i>	<b>30000</b>
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<b>Supervision (8 students in Tbilisi and Yerevan)</b>	8*2000	<b>16000</b>
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<b>Summer school(s) and/or research workshops in Tbilisi/Yerevan</b>	2*20000	<b>40000</b>
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<b>Money for 5 student visits per year to Tbilisi/Yerevan</b>	2*2*5*1000	<b>20000</b>
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<b>Monthly salary for Tbilisi/Yerevan grid clusters support and the purchase of software</b>	30*(250+150, Tbilisi) +30*(200, Yerevan) + 2* 6000 (Software)	<b>30000</b>
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<b>Journals, books for the library</b>	2*2*3000	<b>12000</b>
<b>Total for Tbilisi/Yerevan</b>		<b><u>249,500</u></b>
<b>BONN:</b>		
<b>Visits to Tbilisi/Yerevan: (two weeks)</b>	2*2*[700 air ticket+14*(100+50)]	<b>11200</b>
<b>Equipping the videoconference room at HISKP, University of Bonn</b> <i>(Tandberg videoconference system, local TFT monitor, touchpad, windows-computer for EVO conferences, AXIS webcam, montage)</i>		<b>10000</b>
<b>Support for the visitors from Tbilisi/Yerevan:</b>		
<b>Project member visits to Germany (2 visits per year)</b>	2*2(500 air ticket + 2000)	<b>10000</b>
<b>Students short visits to Germany</b>	3*2*(500 air ticket + 1500)	<b>12000</b>
<b>Two long-term fellowships for PhD students in Bonn</b> <i>These fellowships will be awarded to the PhD students from Tbilisi/Yerevan who will spend half of their time (1.5 yrs.) in Bonn, where they will be employed as WHK</i>	2*16000*1.5	<b>48000</b>
<b>Total Bonn</b>		<b><u>91,200</u></b>

## Justification of costs

### Preparation and delivery of lecture courses

For the preparation and delivery of a single lecture course, 4000 Euro in total is envisaged. It should be made clear that a larger part of the sum, 2600 Euro, will be paid upon the preparation of the electronic script of a lecture course (including exercises and solutions) that will be put on the web-page of the center. This means that this sum will be paid once, upon the first preparation. If there are substantial changes introduced in the script later, paying of a much lesser amount could be eventually made. The delivery of lectures is paid on approx. 20 Euro/h basis, and the assistant lecturer gets approx. 5 Euro/h.

In order to justify the proposed numbers, we first mention that we consider the process of distant teaching to be at the heart of our approach to the regional cooperation. For this reason, we must ensure that the process functions properly.

The lecture script is one important component of this process. As our experience shows, the availability of a well-organized script is of great help for the students, especially in case of advanced courses. This is even more important, when the contact between a lecturer and the students is not direct but occurs only during the videoconferences. **Eventually, the publication of the most popular lecture courses is planned by the Center.** On the other hand, the existence of a clearly defined curriculum, documented in a lecture script, is a key condition for bringing tuition standards in the region close to the high international levels — the process that is voluntarily supervised by the University of Bonn within the framework of the present project.

To summarize, since the preparation of the electronic version of the courses, as well as their delivery through the videoconferences, etc, require substantial effort and time investment, for a proper functioning of the Center we should ensure that the salaries that we offer provide a reasonable incentive for the participation in the work of the Center. We consider the proposed salaries fair, commensurate with the invested work and regionally competitive, therefore justifying the planned costs for holding the lecture courses.

## Organization of the workshops / summer schools

In order to make the costs for the organization of the workshops and summer schools transparent, as an example, we give the estimated calculation of costs for a four-day workshop in Tsakhadzor (40 km from Yerevan) and a six-day summer school that follows the workshop. Around 30 speakers are anticipated to take part in the workshop (8 plenary speakers and 22 speakers with short contributions). The speakers include Georgian and Armenian team members, as well as active scientists both from the region (Turkey, Iran, ...) and outside the region.

### Workshop

Living costs for 30 persons in the Sports Complex in Tsakhadzor for 6 days on 60 Euro/day basis (4 working days plus the arrival and the departure day). These costs include accomodation, meals, costs for the lecturing hall and coffee breaks.	60 X 30 X 6 = 10800 Euro
Transportation costs from and to the airport	500 Euro
Badges, paper, etc	300 Euro
Conference dinner	1000 Euro
Excursion	800 Euro
Air tickets for 8 key participants from abroad, 500 Euro each	4000 Euro
<b>Total workshop</b>	<b>17400 Euro</b>

### Summer school

Accomodation costs for 4 lecturers at the YSU guesthouse on 40 Euro/day basis for 6 days	40 X 4 X 6 = 960 Euro
Two coffee breaks per day for 30 persons, 6 days, on 3 Euro/person basis	1080 Euro
Lunch for 30 persons, 6 days, on 5 Euro/person basis	800 Euro
<b>Total school</b>	<b>2840 Euro</b>

**Total school plus workshop** **20240 Euro**

## **Equipment of the special room for videoconferences**

Below, as an example, we give a calculation of costs for equipping a special videoconference room.

<b>N</b>	<b>Item</b>	<b>Price (Euro)</b>
1	Conference Telephon, Polycom VTX 1000	1100
2	Room based web based conferencing device, Yamaha PJP-50USB	1100
3	Video camera	200
4	Projector Kindermann KX 3200 active	1300
5	Desctop PC + monitor+UPS	800
6	Furniture	2000
7	Air conditioner	1500
8	Room renovation	2000
	<b>Total</b>	<b>10000</b>

## **Office room for the invited professors (Tbilisi)**

<b>N</b>	<b>Item</b>	<b>Price (euro)</b>
1	Air conditioner	500
2	Furniture	1000
3	Room renovation	1500
	<b>Total</b>	<b>3000</b>

## **Equipment of the special room for videoconferences (Bonn)**

It is planned to equip the seminar room II at HISKP, university of Bonn with special equipment for videoconferences. In particular, we plan to install a *Tandberg* videoconference system, local TFT monitor, touchpad, windows-computer for EVO conferences, *AXIS* webcam. The estimated cost is 10000 Euro.

## **About the financial contribution coming from TSU and YSU**

The administration of the TSU declares its readiness to contribute 10000 Euro to the renovation and equipment of the special videoconference room and an office for the invited professors at Tbilisi State university. The full estimated cost for this is 13000 Euro. We would like to stress here the importance of an additional contribution (3000 Euro) coming from the VW foundation: due to the strict internal regulations at TSU, the money provided by the administration can not be directly used for buying the required apparatus of a given specification. The administration of the YSU commits itself to approx 10000 Euro for the renovation and equipment of a special videoconference room.

The administration of the TSU is ready to partially support the visits of TSU staff to Armenia. The total amount of the financial support can not be specified at the moment. The administration of the YSU has agreed to provide University guesthouse for a special price for the visitors which participate the given project.

The administration of the TSU agreed to contribute 5000 Euro to the salary for the personnel of the Tbilisi grid cluster.

The administration of the TSU agreed to submit an application to the Georgian National Science Foundation, requesting 10000 Euro for supporting the research workshop/school at TSU.

The administration of TSU agreed to cover all expenses of publishing the selected lecture courses of the Center.