

JOINT RESEARCH PROPOSAL

Helmholtz Russia Joint Research Group

1	Please select the scientific field and enter manually:	Structure of Matter
OPTIONAL – Please specify Helmholtz Research Programme & Topic		

2	Please state the title of your project: Hunting Supersymmetry at the Terascale exploiting Silicon Photomultipliers
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PERSONALIA OF APPLICANTS

Please complete these fields for the Helmholtz Principal Investigator:

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PROJECT CONTENT

7 **Please insert the estimated duration and the start date of the project:**

36 Months

Start Date (Not before November 2011): **January 2012**

8 **Please give a summary of your project in terms of its content and goals:**

(max. 500 words, plus keywords):

The main focus of this Joint Research Group is the search for Supersymmetry at the Large Hadron Collider (LHC). This search for new physics is accompanied by significant detector upgrade activities, which comprise mainly the application of Silicon photomultipliers (SiPM), a novel technology for the detection of photons in large-scale detectors. The joined effort of DESY and Russian Institutes in constructing prototypes of a hadronic calorimeter triggered worldwide interest in this new technology. This collaboration successfully demonstrated for the first time the suitability of the SiPM technology. For further competitiveness of this technology, the sensor performance must be optimized and for the efficient operation of SiPMs an optimized solution for integration must be found. It has to be proven that the concept is then scalable to a realistic detector system.

Due to their convincing performance, SiPMs have already been chosen for the upgrade of the Compact Muon Solenoid (CMS) experiment at the LHC. This opens the unique opportunity to pursue this technology in both collider communities (LHC and LC) and to utilize maximally the evolving synergies. CMS currently prepares the replacement of the present photon-detectors with SiPMs, requiring new backend electronics with a novel readout technology (μ TCA). As university partner a group of the RWTH Aachen studies the possibility to increase the muon trigger efficiency by a layer of scintillators being also read out with SiPMs.

The goal of the CMS detector upgrade is a major improvement in energy reconstruction and muon trigger efficiency. Both are crucial for physics analyses aiming to answer fundamental questions on the structure of matter. One of the most prominent goals for the LHC is the search for new supersymmetric particles, where DESY and the Russian Institutes are deeply involved. Phenomenological calculations for supersymmetric processes at the LHC and the LC provided by the Russian group will serve as an important ingredient for the physics analyses and will foster a growing together of the young scientists within the Joint Research Group at the same time.

Russian Institutes and DESY are connected by a long-lived and fruitful cooperation. The aim of this proposed Helmholtz-Russia Joint Research Group is the development of this success story towards the next generation. Within the project several excellent young Russian and German physicists and students are supported and get the opportunity for a dedicated entry into a scientific career. The proposed combination of the search for new physics beyond the Standard Model with detector upgrade activities employing new technologies, like Silicon photomultipliers and a new readout standard, makes the project scientifically extraordinary and exceptionally suited for further evolving the scientific career path. Unique synergy

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effects by intensive knowledge exchange between different communities are a specific characteristic of this proposal.

All activities of the Joint Research Group fit naturally into the framework of the Helmholtz Alliance "Physics at the Terascale" between DESY and German universities, taking advantage especially from the Virtual Detector Laboratory, the Analysis Center and the National Analysis Facility.

Keywords:

Particle physics, collider experiments, Large Hadron Collider (LHC), Next Linear Collider (LC), detector development, Silicon Photomultiplier (SiPM), Hadron Calorimeter, Muon Detector, Scintillators, μ TCA, Supersymmetry, Phenomenological Calculations, Energy Flow, Energy Reconstruction, Jet reconstruction, Reconstruction of Missing Transverse Energy, Muon Trigger, Physics beyond the Standard Model (BSM), Monte Carlo Simulation, CompHEP, Helmholtz Alliance, Helmholtz Analysis Center, Virtual Detector Laboratory, National Analysis Facility, Helmholtz Young Investigator Group

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(Please give a detailed outline of the project; max. 15 pages)

Motivation

The Large Hadron Collider delivers a constantly increasing amount of data, opening the door to searches for new physics such as Supersymmetry, where German and Russian institutes are deeply involved. To strengthen these efforts, a new Helmholtz-Russia Joint Research Group is proposed, which not only investigates new physics questions, but also contributes to hardware projects. The feasibility of such a large-scale project has been demonstrated by a previous Joint Research Group (HRJRG-002), which evolved the long-lived cooperation between DESY and Russian Institutes successfully from the past towards new experiments. The former Joint Research Group established new strings between young physicists working for experiments at different colliders. The proposed Joint Research Group not only tightens the strings further, but incorporates now a Helmholtz Young Investigator Group as an addressee of the next generation. As a novelty it also includes a German University in this common effort. The concept of connecting detector development and operation with data analysis conveys all skills mandatory for a leading particle physicist. Therefore, several young scientists of the former Joint Research Group stayed in particle physics, being employed by internationally recognized research institutes or universities.

The physics activities in this proposal are based on the physics program of a Helmholtz Young Investigator Group, whose leader will be the Principal Investigator on the German side of this Research Group. Mutual benefits make this arrangement very attractive by complementing the program of the Young Investigator Group with a hardware activity on one side, while opening for the other side the possibility of data analysis in a running experiment.

This proposed Joint Research Group connects activities of all participating institutes on two levels: Analysis and upgrade projects for the running CMS experiment at the LHC – and research and development for a detector at a future linear collider (LC), which makes this proposal

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scientifically extraordinary and exceptional. The activities will be intensified not only between the German and Russian institutes, but also between the members of the different experiments, which guarantees the feasibility and a fruitful completion of the ambitious goals.

After several years of development, the novel technology of SiPMs is now mature and available at moderate costs. In the framework of detector R&D for a future LC they have been established as a suitable choice for hadronic calorimetry. Therefore, they are an excellent option for detector upgrades planned for running CMS experiments at the LHC, again concentrating on hadronic calorimetry and added by muon identification.

The driving force for challenging detector developments in high-energy physics is always the primary goal of understanding the structure of matter. This proposed Joint Research Group works on physics analyses, which can be performed especially with the specific detector components, the hadron calorimeter and the muon detector. The physics analyses concentrate on one of the primary goals of the LHC, the searches for supersymmetric particles as sign for new physics. Here data analyses are complemented by phenomenological and theoretical calculations.

The interconnections between the different activities are visualized in Fig. 1 and will be discussed in detail in the following pages.

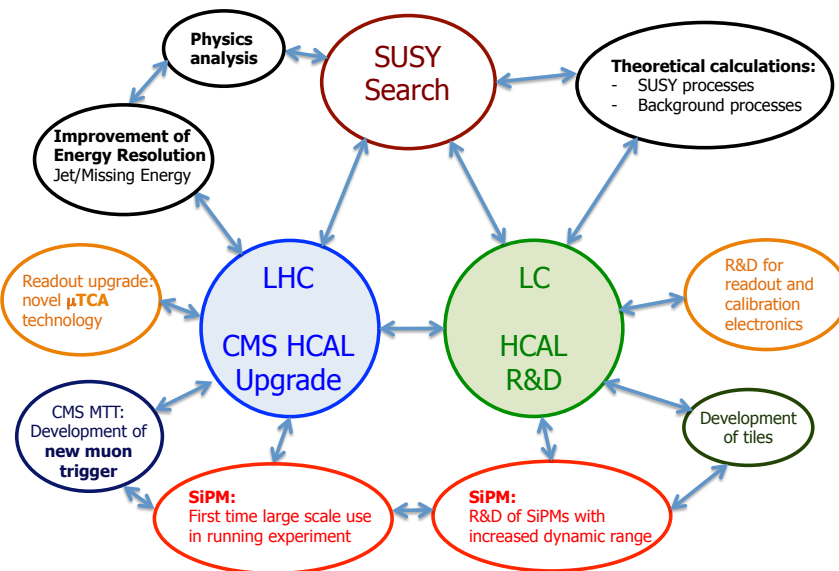


Fig. 1: Interconnections between the different research topics

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Introduction

The major achievement of particle physics in the second half of the 20th century is the development of the Standard Model. It describes three of the four known fundamental forces, the weak, the electromagnetic and the strong force, within the electroweak theory and the quantum chromodynamics. However, it describes only about 5% of the constituents of our universe (intergalactic gas, stars, planets), and cannot explain the origin of Dark Matter (22%) and Dark Energy (74%, see Fig.2). In addition, it does not include the fourth force, the gravity, and leaves a number of questions open, among them:

- Do the four fundamental forces unify at large energies?
- What is Dark Matter made of?
- Why is there more matter than anti-matter?

Supersymmetry (SUSY) is one of the most attractive theories providing a framework for the unification of all four forces. In addition, most SUSY models propose a light stable supersymmetric particle (LSP), being neutral, weakly interacting and therefore invisible for our detectors so far. These LSPs are promising candidates for dark matter.

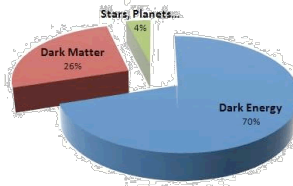


Fig. 2: Constituents of the universe

Within SUSY, to each known elementary particle degree of freedom one partner particle is assigned, which differs by half a unit of spin. Therefore, for every type of boson there should exist a corresponding type of fermion with the same mass and quantum numbers, and vice-versa. As these particles have not been found, SUSY must be a broken symmetry, leading to partner particles of higher mass. As of now these superpartners have not yet been detected, but their masses should be (at least partly) below 1 TeV in order to solve the hierarchy problem and allow unification of the forces. In this case they are expected to be within the reach of the Large Hadron Collider (LHC), which started data-taking in 2010. Searches for predicted effects by SUSY, especially by the simplest realistic supersymmetric model, the so-called Minimal Supersymmetric Standard Model (MSSM), are a main part of the physics program of the LHC and of a future linear collider (LC).

To reach as far as possible into new physics territory, an upgrade of the detectors with novel technology is essential. Therefore, this Joint Research Group comprises detector R&D, construction and operation as well as the physics analysis of the recorded data and timely publication of the achieved new scientific results and insights.

The detector part of this Joint Research Group proposal consists of three main items:

- Detector upgrade activities for the improvement of the CMS HCAL with:
 - Silicon Photomultipliers (SiPMs),
 - μ TCA technology;
- Detector R&D for the CMS Muon Track Trigger using SiPMs;
- Research and development of a hadron calorimeter for the future LC using SiPMs.

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The physics part of this Joint Research Group proposal comprises:

- Search for Supersymmetry (SUSY) at the LHC;
- Optimization of energy reconstruction and muon detection with the upgraded CMS HCAL;
- Phenomenological calculations of various processes connected to SUSY searches at the LHC, taking advantage of the latest results for the proton structure derived from HERA data;
- Theoretical calculations for SUSY and Standard Model processes as well as preparation for precision measurements at the LC.

These activities will be described in detail below.

The Large Hadron Collider and the CMS Experiment

The following section introduces the Large Hadron Collider (LHC) and the CMS experiment, which is one of the two large multi-purpose experiments at the LHC.

The Large Hadron Collider

The Large Hadron Collider (LHC) at CERN near Geneva is the world's largest collider, reaching the highest energies, which have ever been achieved at a collider. It has a total circumference of 26.7 km and will provide the energy of 14 TeV in proton-proton collisions. It is designed for a final luminosity of up to $10^{34} \text{ cm}^{-2}\text{s}^{-1}$, where the luminosity is a measure of the expected event rate of different processes per time interval.

Two multi-purpose experiments, ATLAS and CMS (Compact Muon Solenoid), are designed to perform high quality measurements of particles like leptons, hadronic jets and high energetic photons, which are produced in the collisions.

After a very successful startup in 2010 with the energy of 7 TeV and a lower luminosity, the LHC will run until spring 2013, with continuous improvements. Already now it has reached several new world records for a hadron collider, e.g. a luminosity of $4.67 \times 10^{32} \text{ cm}^{-2}\text{s}^{-1}$. This exceeds the previous world record set by the US Fermi National Accelerator Laboratory's Tevatron collider in 2010, and marks an important milestone in LHC commissioning.

For the next years the present LHC operation scheduled assumes

- Physics data taking until mid 2013;
- Technical stop for machine development until early 2015;
- Continuous physics data taking with small winter technical stops (~8 weeks) until end 2018.

This schedule is very important for all upgrade projects, as they have to adapt their own schedules to the availability of the LHC.

The CMS Experiment

The CMS detector, shown in Fig. 3, has a length of 21.6 m, a diameter of 14.6 m, and a total weight of 14500 t. Specific to CMS is the highest possible magnetic field (3.8 T in the central region), combined with an inner tracker consisting solely of silicon pixel and silicon micro-strip detectors, which provide high granularity at all radii.

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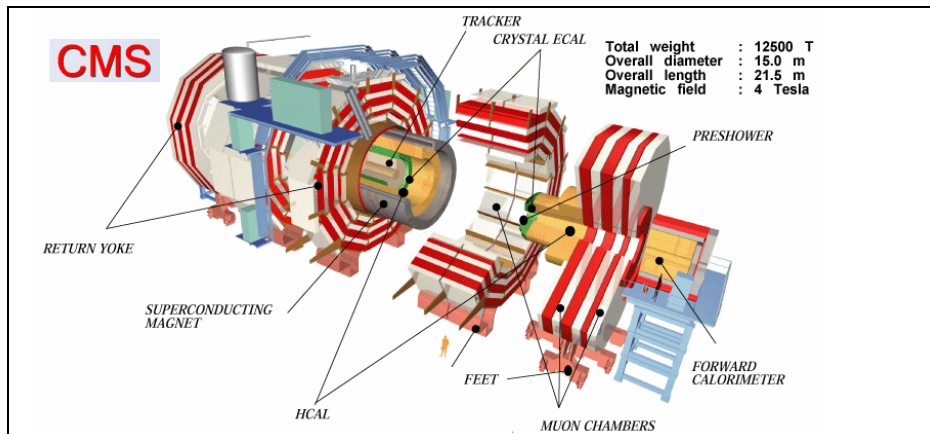


Figure 3: The CMS Experiment

The detector is composed of several layers, starting from inside to outside with the tracker, which is used to measure charged particle momentum (pT), followed by the electromagnetic and the hadronic calorimeters, measuring particle energies, the magnet and the muon chambers. These provide important input for the trigger, with which it is decided, if the event is relevant for the studied physics and recorded or not.

The hadronic calorimeter (HCAL) is essential for searches for new physics in higher energy ranges. Especially for SUSY searches, as aimed for in this Joint Research Group, rely on excellent jet and precise missing transverse energy measurements.

With the data taken so far, many analyses have been performed, impressively showing that all detectors are very well understood. After the successful re-discovery of the Standard Model, the search for signs of new physics has already started – and in most cases – enlarged the limits from previous experiments (see Fig. 4). This is a clear demonstration that now the new domain at the Terascale has been successfully entered.

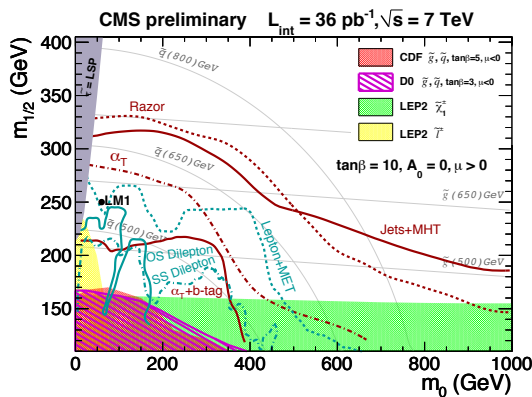


Figure 4: Limits from CMS 2010 data taking (red and turquoise lines) in comparison

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CMS Upgrade Projects

For the optimal use of the upgraded LHC machine, the detector needs to be upgraded as well. Detailed studies show for example in case of the CMS HCAL, that a replacement of the Hybrid Photo Detectors (HPDs) by SiPMs can improve its energy resolution and linearity. Figure 4 displays the layout of the CMS HCAL system divided into HCAL Barrel (HB), HCAL Endcap (HE) and HCAL Outer (HO). The left side depicts the current situation and the right side the envisaged situation after the upgrade of the HPD photon sensors with SiPMs.

SiPMs for the HCAL

Just recently the SiPM technology has become available commercially at reasonable costs. The SiPMs provide the high gain needed for additional longitudinal segmentation of the HCAL. Therefore, the CMS HCAL group is planning the replacement of the HPDs with SiPMs.

Within the Young Investigator Group of I. Melzer-Pellmann substantial studies have been performed to explore the possible improvement of the energy reconstruction by developing weighting procedures comparable to those of the H1 Experiment at HERA and those of the LC HCAL group. The simulations have shown that an improvement of the energy resolution of about 8% is feasible, including an improvement of the linearity. The good simulation results have been verified by applying the developed weighting factors to the test beam signals taken in summer 2009.

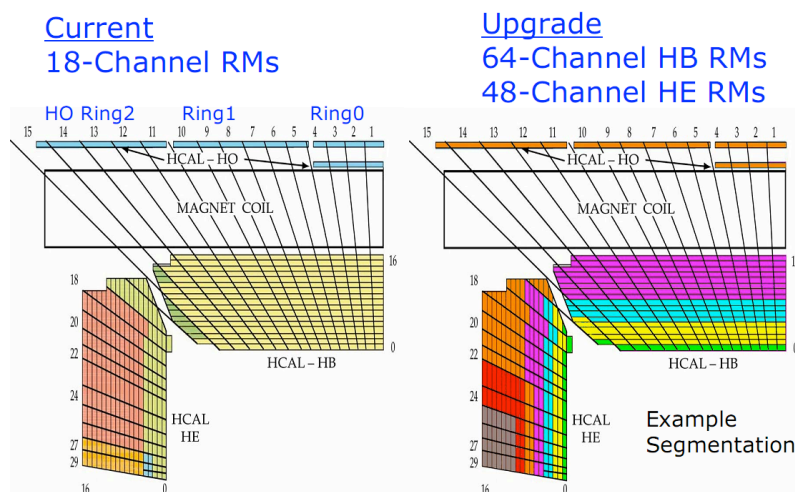


Figure 4: Layout of one quarter of the CMS HCAL system with the current segmentation (left) and a possible segmentation after the upgrade with SiPMs (right).

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The upgrade of the HCAL in the barrel (HB) and the endcap (HE) regions is envisaged to take place in combination with the exchange of the pixel detector around 2016/2017 during a prolonged winter technical stop. This upgrade comprises:

- Replacement of the HPD's with SiPMs;
- Development of a new Electrical Decoder Unit to accommodate the new depth segmentation;
- Separate TDC readout for timing information on at least some of the channels;
- New frontend readout with a further developed QIE chips;
- New backend electronics system employing the commercial standard μ TXA, which provides the necessary flexible and high bandwidths (described in detail below).

While for most parts of the upgrade the progress of developments look promising, the main challenge seems to be the development of suitable SiPMs, which meet the necessary requirements. Different SiPM sensors with quite opposite characteristics have been investigated, for example 30,000 pixels/cm² with 1 μ s recovery time and 5,000 pixels/cm² with 100ns recovery time, but the optimum also meeting the needed radiation hardness is not yet found. The final choice of SiPM sensors will influence clearly the way of reading out the optical signal with the SiPMs and how to operate and monitor the SiPMs.

The dynamical range of a SiPM can be increased by distributing the light, which is produced in the calorimeter tiles, uniformly across the sensitive surface. Therefore optical light mixers have to be developed and optimized.

The first step of the HCAL upgrade is the replacement of the HPDs in the outer region of the barrel HCAL. With the finer granularity aimed at with the further HCAL upgrade, more channels have to be read out. This requires an upgrade of the front end (FE) and back end (BE) electronics in the read-out. The novel technology of μ TCA has been chosen. Contributions in this area open the possibility to maintain the competence of the participating institutes in readout electronics with in a timely fashion and nice opportunities for students work. The upgrade of the BE electronics will start together with the HO upgrade in the long technical stop starting mid of 2013 and lasting until early 2015. For about 1/3 of the readout, splitters will be installed, such that the running readout and the new readout under development can be operated in parallel. Further installations are possible in the shorter technical stops. Finally, when also the pixel detector will be replaced, possibly in the prolonged technical stop 2016/17, the full HCAL upgrade including SiPMs, FE and full BE electronics is planned, as can be seen in Fig 5.

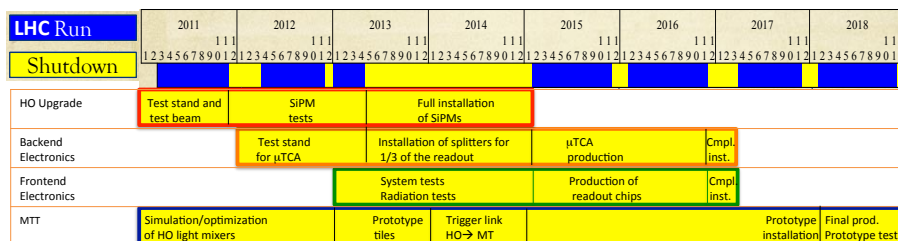


Figure 5: Part of the HCAL upgrade schedule

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HO Upgrade

With the start of the operation it turned out that the performance of the HPDs in the HCAL Outer (HO) is strongly compromised from the misalignment between the CMS fringe magnetic field and the electrical field, making this is a natural starting point for the upgrade. The HO is divided in five rings. The CMS HCAL group at Fermilab and a group from India have made a collaborated effort to perform the exchange the HPDs of the outer rings (Rings 1 and 2) within the next shut down. The DESY group will replace the central ring (Ring 0) with funding of the Landesexcellence (1000 SiPMs bought). The aim is to be ready as early as possible, in order to be prepared for the installation of an already burned-in system in case of an earlier shut down. The proposal has been approved in an Engineering Design Review. The exchanged HPD's will be harvested and stockpiled as spares for running HB and HE.

Already now the HPDs in two readout boxes, one in HO Ring 1 and one in HO Ring 2, have been replaced with in total 144 SiPMs, which are successfully operated. In these readout boxes the electronics have been replaced by sets of one SiPM card and one SiPM control card, everything else stayed the same.

Using SiPMs, the signal to noise ratio has been measured to improve from $\sim 2:1$ with the HPDs at the necessary decreased HV of 6.5 kV, to about $\sim 40:1$, as shown in the examples in Fig. 6, which clearly demonstrates the better separation between the pedestal and the muon signal.

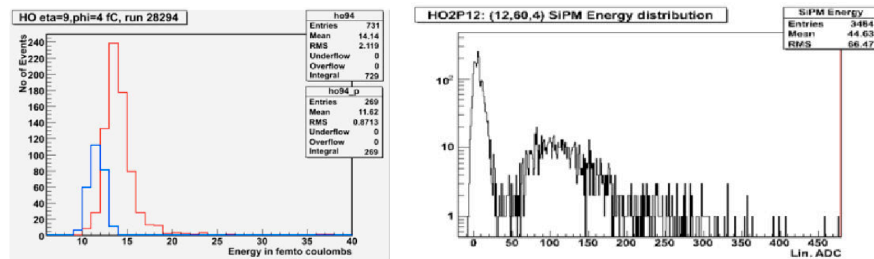


Figure 6: Comparison of the muon response in HO with HPD (left: blue is pedestal, red is muon signal) and SiPM (right: the left high peak is the pedestal, the broader maximum the muon signal).

The μ TCA Technology for the HCAL

Pre-requisite for a sensible upgrade of the readout is the upgrade of the backend electronics. The current system is not able to cope with the increased data volume provided by a calorimeter with higher granularity, having in mind that the luminosity will increase to a level where zero suppression is no longer as effective as it has proven to be at lower luminosity. More-over the demands on efficient event filtering will be much harder to meet with increasing luminosity, and a more flexible and powerful data path to the calorimeter trigger is needed.

All these requirements could not be fulfilled easily with the current back end setup based on VME technology and it was decided to take up the challenge of a technology swap and upgrade the back end electronics to μ TCA.

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The μ TCA technology is on its way to become the new standard for many different kinds of digital applications in high-energy physics. Developed by telecommunication industries, μ TCA follows the trend of replacing parallel by serial connections. It will be a key technology for DESY for many upcoming projects. The XFEL accelerator control will be much more digitally driven than it was the case for accelerators before. This raises the necessity of high-speed digital communication paths, and it was decided to use the μ TCA bus for the local data transfer also here. For XFEL detectors the data rates to be handled are in the same range as for LHC experiments. Also here it was decided to use TCA in different flavors (ATCA and μ TCA) to transport and process the data coming from the detector.

μ TCA also plays a major role as base technology for next linear collider. For all HEP groups at DESY the μ TCA is the technology of choice. While the requirements of the different μ TCA projects are quite different, there is a large number of common problems. Achieving synergies by providing common solutions for common problems seems easily possible.

Nevertheless, the flexibility of μ TCA CA is not for free: while it took not more than pressing a button to get a VME crate running it is much more difficult to put a μ TCA crate into operation. Dedicated software is needed to run μ TCA hardware. Since the hardware and software environment of a large physics experiment like CMS is very special and evolving, vendor propriety software cannot be used and an HEP community open framework for μ TCA slow control is needed. This includes simple things like switching on and off complete crates as well as individual boards, monitoring of power supplies and fans, keeping track of temperatures and configuring backplanes. It also includes the installation and configuration of the firmware of the FPGAs, which can be found on nearly every μ TCA board.

It is planned to integrate the HCAL μ TCA systems into the central Detector Control System (DCS) and into the Data Acquisition System (DAQ). Since DESY and MSU have already gained a lot of experience in the slow control of the HCAL sub-detector CASTOR, one of the preferred fields of activity to start with is related to the control and monitoring of μ TCA setups.

The Muon Track Trigger

The necessity for the proposed MTT arises from the fact that the level-one (L1) trigger rate is affected by mis-measured low-pT muons crossing the trigger threshold. The aim is to limit the trigger rate to the present L1 trigger rate even at luminosities of $10^{35} \text{ cm}^{-2}\text{s}^{-1}$ as envisaged for the LHC phase 2 upgrade. This can be accomplished by either applying a significantly higher pT threshold or by a more efficient L1 trigger, comparable to the present L2/L3 trigger levels (see Fig. 7). A higher pT threshold severely limits the physics capabilities of the CMS detector and therefore it is necessary to measure pT more precisely. Since the measurement of the drift tubes at low pT is limited by multiple scattering the only way of improving the drift tube measurement is by including some hit at low multiple scattering, implying the inclusion of Tracker information at L1.

The basic idea is to identify a muon hit behind the calorimeters and the solenoid. With this signal a search region inside the Tracker (region of interest) can be defined. Then there are two options to proceed: Either a fast tag is sent to some Tracker layers (L0 trigger) and promising hits are received (selective readout) or a match is done with Track-Trigger primitives (stubs) inside the region. Two different scenarios for the realization of the MTT hardware are considered: One are

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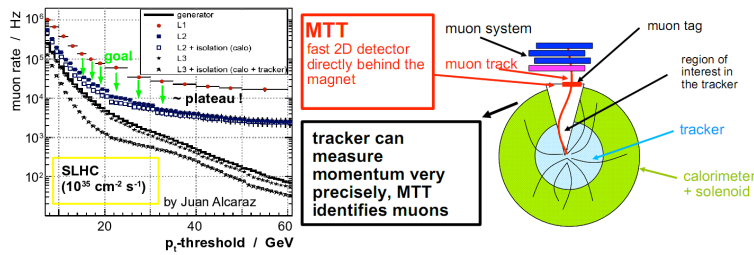


Figure 7: Left: The aim is to keep the present LHC L1-trigger rate ($\sim 100\text{kHz}$) also at high luminosities at super LHC (up to a factor 10 higher) without raising the muon- p_T threshold.
Right: Hardware concept of the MTT.

new RPCs with 2D readout, the other one is an additional layer of scintillator tiles read out with SiPMs, studied by the group of RWTH Aachen University. A software setup for GEANT4 simulations of light transport in scintillator tiles and wavelength-shifting fibers was already established.

Now detailed studies of the HO light mixers for the SiPMs as well as of scintillator-tile prototypes are underway. In the future this setup may also serve to study models of prototypes for the Linear Collider HCAL tiles.

The principle layout as displayed in Fig. 8 is pretty similar to the one of HO. Other than the HO scintillator tiles, the MTT modules however would need to be designed for maximum speed and discrimination power for muons.

Having a similar granularity of about $30 \times 30 \text{ cm}^2$ as envisaged with $25 \times 25 \text{ cm}^2$ for the MTT, the HO Ring 0 would be an ideal test case to study the feasibility of the concept, the operating conditions and the achievable performance increase. In addition, a trigger link is prepared in the readout of the HO rings, which can be connected to the muon detector. If this trigger link can be established, the data will provide valuable input for further studies. The fact that the HO Ring 0 consists of two layers of scintillators leads to a considerable enhancement of the muon detection efficiency in comparison to the other HO Rings with only one scintillator layer.

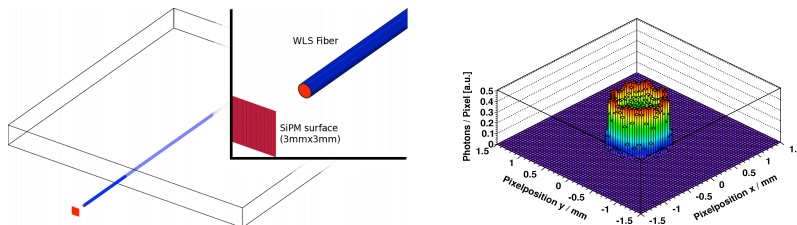


Figure 8: Left: Scintillator tile with wavelength-shifting fiber and active SiPM surface.
Right: Distribution of incoming photons on the SiPM surface.

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A Hadron Calorimeter for the next Linear Collider

The following chapter introduces the concept of a future Linear Collider (LC) and a hadron calorimeter for an experiment at a LC, which meets the requirements of a full particle flow reconstruction, in which each particle in an event is measured individually, holding the potential of optimizing detector performance also at high energies.

The next Linear Collider

An electron-positron Linear Collider (LC) is considered to be the next big accelerator project in elementary particle physics. It will be the ideal and indispensable facility to perform precision measurements on the new particles and phenomena, which the LHC is expected to reveal. While the energy range of the collider and thus the technology of the accelerator will depend on the physics results from the LHC, the experimental techniques are essentially the same and are being developed in a joint effort in the community. Two main accelerator techniques are currently under investigation: The International Linear Collider (ILC), which could work in the range 0.5-1 TeV, and the Compact Linear Collider (CLIC), which is planned to reach energies up to 3 TeV.

The Hadron Calorimeter Project

There are however additional challenges at a multi-TeV machine such as CLIC, which have recently become the subject of an increased R&D effort at CERN and elsewhere. One of the focal points of this effort is highly granular hadron calorimetry, where the challenges arise from the need for denser structures to cope with higher particle energies, and fast timing response to prevent the increased background from pile-up on the signal.

Within the framework of the new Joint Research Group we plan to consolidate and extend the applicability of the SiPM technology, and to ensure their competitiveness for the full range of energies considered for a future collider.

DESY and its Russian partners cooperate since the 1980s on the development of photo-sensors and their applications. In 2003, the first small calorimeter prototype with SiPMs was successfully tested in the DESY test beam and triggered a growing interest worldwide in the technology. In 2006 the groups together with American, British, Czech and French partners commissioned the first large-scale detector prototype at CERN, which established the SiPMs as robust and reliable for mass applications and the finely segmented “imaging calorimetry” as feasible.

In the framework of the previous Joint Research Group this was further pursued and consolidated. The groups carried out extended test beam campaigns at CERN and Fermilab and cooperated intensively on the analysis of the data, demonstrating the potential of high granularity for the improvement of energy resolution by means of software compensation and applied particle flow reconstruction algorithms to test beam data, thereby validating the predicted jet performance for a future collider.

On the technology frontier, the SiPM scintillator tile system as shown in Fig. 9 was optimized and simplified. Improved sensor performance, above all in terms of signal over noise ratio, allowed for thinner tiles and thereby reducing the cost- sensitive detector volume, and the new tile and fiber design are scalable in size for arbitrary detector layer dimensions and amenable to mass production.

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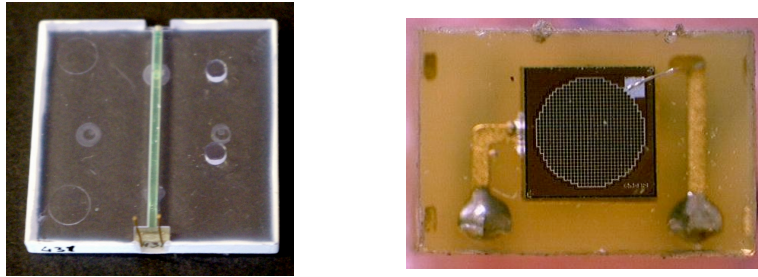


Figure 9: Scintillator tile with WLS fiber and SiPM (left); SiPM developed at ITEP and CPTA (right).

An integrated active readout layer was developed with front-end chips integrated into the detector volume, and indispensable step without which the high transverse segmentation would lead to unmanageable connectivity problems. A prototype layer with new sensors, tiles and electronics has successfully been tested in the DESY test beam.

In the period covered by this proposal DESY and ITEP plan to jointly address the next integration steps and the extension of the applicability to the high-energy case. At multi-TeV collision energy the calorimeters conceived for the next LC cannot contain the hadron showers anymore sufficiently well, and leakage deteriorates the energy resolution. Since the calorimeter cannot be made deeper, due to limitations for the dimensions of the superconducting coil surrounding it, it must become denser, and tungsten has been proposed as a suitable absorber material, on the basis of simulations. These simulations must be checked with test beam data. Tungsten as an absorber sharpens the integration requirements, since, with respect to steel, individual layers get thinner by about a factor of two and reduce the space available for external layer interfaces and services.

The groups plan to cooperate on the following topics:

- CALICE test beam studies with new absorber materials and new active detector elements and data analysis;
- Electronics integration for fine longitudinal segmentation;
- R&D on SiPM-tile system, in particular the development of new SiPMs with improved dynamic range and development of direct tile-SiPM coupling.

CALICE beam tests

Preliminary results from the CERN test beam data have already been presented at conferences and support the particle flow approach while also providing interesting constraints to hadron shower simulations with unprecedented level of detail. The analyses need to be finalized and extended in energy range by including data taken at Fermilab. In the meantime, absorber modules made of tungsten have been produced at CERN for the existing CALICE test beam set-up, and first tests of such a structure using the well understood scintillator SiPM active layers of the large prototype have started last year and are scheduled to continue in 2011. Hadronic interactions with the heavy Tungsten nuclei produce much more neutrons compared to Iron, therefore shower modeling and reconstruction algorithms must be individually analyzed. At a later stage, the

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second-generation active layers will be used to explore Tungsten: they are not only more compact, but the new electronics also enables timing measurements with nanosecond accuracy. With this feature, the shower evolution and delayed detector response due to slow nuclear de-excitation can be observed, and time stamping capabilities for background rejection be evaluated.

Electronics integration

The concept of an imaging calorimeter cannot be transported from test beam to a whole detector, where the several millions of individual channels cannot be supplied and read out without deteriorating the overall performance with more than an absolute minimum of dead spaces. While this has now been solved in the transverse dimensions, compact layer interfaces for data acquisition, optical calibration and power supply will be designed at DESY now. This is already necessary for a validation of the performance of the embedded electronics with power-pulsing and on-line zero-suppression in a small stack structure for electron beams, and of course also for the timing studies with neutron-rich hadron showers in a Tungsten absorber.

R&D on SiPM-tile system

The SiPMs developed at ITEP and Centre of Progressive Apparatus and Technologies (CPTA, Moscow) are used in the engineering prototypes of the LC HCAL. The response variation of these sensors with temperature is three times lower than for the SiPMs from HAMAMATSU, which is a big advantage for the HCAL application. The area where further improvement of the CPTA/ITEP SiPM is desirable is its dynamic range, which is limited by the number of pixels. New SiPMs with significantly increased number of pixels will be developed. Since higher pixel density results in the geometrical efficiency loss and increase of inter-pixel cross talk, careful optimization is necessary.

The nonlinearity of the SiPM response can be corrected by using saturation curves measured in the laboratory. We plan to perform detailed studies of the saturation curves, in particular, of the effect of the non-uniformity of the illumination of the SiPM by the light coming from the wavelength shifting (WLS) fiber (see Fig. 8). Introducing the gap between the fiber and the SiPM could improve the uniformity and will be subject of the optimization at ITEP, who will produce the SiPM-tile systems that are required for the HCAL prototypes.

The WLS fiber converts the blue scintillation light into the green region in which the sensors are most efficient and ensure uniform response, independent from the exact position in the tile where the light was generated. With the advent of blue-sensitive SiPMs direct (fiber-less) read-out becomes possible, which in principle can simplify design and production considerably and should also provide a faster detector response. However, the uniformity must then be ensured by other means, e.g. special modifications of the tile geometry near the sensor, and the whole system must be re-optimized. ITEP will work on the development of tiles for direct readout, optimization of the photo-sensor matching, and will perform measurements of tile uniformity. The technology for mass production of direct-readout tiles using injection-moulding must be optimized, too. Simulations on this topic will be performed by the RWTH Aachen.

All activities are well embedded in the international R&D effort for detectors at a future LC. They are part of the activities of the international CALICE collaboration, which investigates calorimeter technologies for a linear collider, and where one of the DESY key researchers (FS) acts as spokesperson and project leader for a scintillator HCAL. Recently an integrated research

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infrastructure activity within the European framework programme 7 has been approved; the AIDA project is a follow-up of the successful EUDET initiative, and the tungsten HCAL development is one of the projects supported by the EU within AIDA. Finally, the planned test beam activity with existing scintillator and new layers and a tungsten absorber structure is one of the show cases for the synergetic cooperation between the ILC and the CLIC oriented detector development. Within this environment, the proposed HRJRG would have a strong impact on the competitiveness of technologies developed DESY and the Russian institutes, and further strengthen the strategic partnership between them.

Search for Supersymmetry

With all detector upgrades described above, a more precise data analysis is possible, extending the mass range for the discovery of supersymmetric particles.

One of the most important observables for the identification of SUSY events is missing energy, as the lightest supersymmetric particle (LSP) is supposed to escape from the detector unseen, thus carrying energy away. Therefore, it is important to measure the total energy deposited in the detector as precise as possible. One of the bottlenecks of this measurement at the CMS experiment is the barrel part of the hadron calorimeter (HCAL), as it is not thick enough to always stop very high energetic particles. Those particles, which escape the inner part of the HCAL, are supposed to be detected by the HCAL outer part (HO). Due to deficiencies of its Hybrid Photo Detectors, the HO is currently not included in the reconstruction. This will change when the HO will be equipped with SiPMs.

The group within CMS, which is developing the reconstruction utilizing the Particle Flow algorithm, is very interested in including the information of HO, as it will improve the measurement of jet energy and missing energy as well. With the upgrade Phase 1, when the HCAL Barrel will also be equipped with SiPMs and can be read out with longitudinal segmentation, further improvement of the energy resolution and linearity is expected, when a weighting algorithm can be applied.

The ITEP group plays the leading role in the hadronic calorimeter operation and analyses based on the calorimetric data. Before the comprehensive search for new phenomena using hadronic high-energy jets we first plan to understand better the calorimeter response to these jets, jet structure and various statistical distributions, directly related to the hadronic jet properties. As the next step a study of various QCD Standard Model processes will be made using the hadronic calorimeter. The inclusive differential cross sections for high-energy jet production as well as jet multiplicity will be measured. Once the high data quality and complete understanding of the calorimeter response are established the group starts to look for the signals from various phenomena beyond the Standard Model.

The DESY and SINP MSU groups are both involved in the international worldwide studies of SUSY effects at colliders. One of the common subjects of interest is the search for light gluinos decaying only to 3rd generation squarks in the CMS experiment at CERN and at a next linear collider (LC). The DESY Young Investigator Group has experience in data analysis at CMS, being the driving force in this specific analysis. On the other hand the SINP MSU group has expertise in Monte Carlo event generation and modeling of signal and background processes. The Moscow group uses the well-known computer program CompHEP, which was developed in SINP

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MSU. It allows proceeding from the construction of new model to computation of cross section and distributions and generation of unweighted events. The generated events are presented in Les Houches format, so that the MC event samples are ready to be used by other programs like the CMS-software to take into account realistic fragmentation and detector response. The CompHEP code is very useful in common studies, because it has built in the Lagrangian of the MSSM, so one can compute needed processes of stop production and decay, and easily change MSSM parameters etc. The needed simulations as well as data analysis requires considerable computing facilities. SINP MSU has such a great potential as the TIER-2 center for computing resources as well as DESY, which in addition hosts the National Analysis Facility (NAF).

Both groups are participating in the CMS collaboration at CERN. In the common proposed project a special attention will be paid on possible impact of CMS stop studies on prospects of stop properties measurements in future experiments at the next LC, where they might be used as basic processes to study the LC detector capabilities for investigation of BSM physics.

To perform the precise measurements of corresponding cross sections of new particles, detailed predictions of SM background are needed.

At LHC energies, QCD is believed to be correctly approximated by BFKL or CCFM evolution equations and therefore the cross-sections should be calculated using the kt-factorization QCD approach, where off-shell (depending on the incoming partonic transverse momenta k_t) matrix elements are convoluted with the kt-dependent (unintegrated) parton densities. The main advantage of such an approach is that each emitted gluon is assumed to take a large fraction of the energy of the propagating gluon and large logarithms of $1/x$ are summed up to all orders. The group at SINP MSU performs the development of the kt-factorization approach and its phenomenological applications to the different processes. In particular, it was applied to the prompt photon, electroweak boson, heavy-quark and quarkonium production at HERA, LEP2 and Tevatron conditions. In the framework of present research program it is planned to continue these investigations and extend them to the LHC and next LC.

It is planned to study events with isolated photons, which are an important tool to investigate hard interaction processes, as they emerge without the hadronization phase. Good understanding of the production dynamics is also important for searches of new particles decaying to photons at the LHC conditions. First applications of the kt-factorization approach to the photo-, lepto- and hadro-production of prompt photons have already been performed by MSU group, and the results were used to analyze recent HERA experimental data. In the framework of the present research program it is planned to extend the developed formalism to LHC and LC energies and study more exclusive final states (like photon + jet). These processes are more sensitive to the underlying QCD process than inclusive photon events.

Another subject of planned studies, which is closely related to the prompt photon and W/Z production, is the Drell-Yan pair production. Accurate calculations of these benchmark processes are an essential component for the LHC discovery program, as they are one of the main background processes in new physics searches with lepton final states, in which the DESY group is involved.

The combination of theoretical and phenomenological calculations, data analysis of recent CMS data, detector upgrade with novel technology and R&D for future experiments will not only contribute to a all-round education of the participating young scientists, but is also a guarantee for excellent and outstanding scientific results.

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10 Please describe briefly (bullet points) (i) how your project will create added value for the partners involved, (ii) what are the innovative aspects of your project, and (iii) which are possible future applications of the results of your project:

(i) Added Value:

- Transfer of the long-lived co-operation between Russian Institutes and DESY towards new experiments with establishing/founding connections in the new generation;
- Establishment of a new and fruit-full collaboration between Russia and a German University (RWTH Aachen);
- Sustainment and amplification of the strong role of the partner institutes in particle physics;
- Increase of visibility and reputation within the large and internationally very competitive collaborations with distinguished projects in detector technology integration and physics analysis;
- Benefiting from synergy effects evolving from knowledge exchange between different communities in detector development, experimental and theoretical physics;
- Scientific and financial support for the education of young academics (students);
- Scientific and financial support during the development phase of excellent young scientists towards leading positions in particle physics;
- Strengthening of the infrastructure in the institutes;
- Provision of funds for constructing invaluable proto-types for further developments.

(ii) Innovative Aspects:

- Supersymmetric models provide solutions to fundamental open questions concerning the interaction of particles, dark matter and the asymmetry between matter and anti-matter.
- New phenomenological and theoretical calculations will pave the way to interpret the measurements at the LHC and the LC by distinguishing between different models of new physics.
- SiPM sensors are a novel technology, which will be further developed, consolidated and established in going from the LC prototype towards the LHC experiment.
- The optimization of the SiPM sensors will lead to a widening of their application opportunities.
- The Joint Research Group will contribute to the built-up of the first large-scale SiPM-based detector in a running experiment.
- The novel technology of μ TCA is employed to replace the out-dated and too inflexible readout electronics.
-

(iii) Possible Future Applications:

- The activities proposed in this Joint Research Group represent important work for the discovery of Supersymmetry or other physics beyond the Standard Model at the LHC and preparations for their characterization at the next LC.
- SiPMs have a wide field of application in high-energy physics as well as in medicine, biotechnology and radiation detection. The questions addressed are of general relevance for all kinds of detectors and different purposes in particle physics, but also for multi-channel applications beyond high-energy physics.

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- The technology of the μ TCA is also on its application way in the LC collider detectors as well as in applications for the machine and detectors at the XFEL. Widely valid standards are about to be defined at DESY. The mutual collaboration in this area will accelerate the developments.

11 **Please describe briefly (by name) how young scientists (PhD-students) will be involved in this project and what will be their role**

Alexander Bylinkin (ITEP, Diploma-student): WP1, WP3

- Physics analysis at CMS
- Participation in the CMS HCAL development/upgrade
- Finishing phenomenological analysis of hadron production at high energy colliders (work started in HRJRG-002)

Oleg Markin (ITEP, Junior scientist): WP1, WP7

- Analysis of LC HCAL test beam data
- Optimization of algorithms for the reconstruction of hadronic showers

Maria Erofeeva (ITEP, Phd-student): WP1, WP3

- Study of jet shapes with the CMS HCAL
- Search for Higgs boson decaying to two tau leptons
- Participation in the CMS HCAL development/upgrade

Maxim Malyshev (MSU, PhD-student): WP1

- LHC phenomenology and Monte Carlo generators

Ilya Kudryashov (MSU, PhD-student): WP4, WP7

- Development of readout electronics for Silicon detectors
- Analysis of CMS HCAL data

Dr. Benjamin Lutz (DESY, Postdoc-Fellow): WP2, WP3

- Construction of a test stand for SiPMs
- Simulations for HO SiPMs
- Implementation of HO SiPMs into the detector

Jakob Salfeld-Nebgen (DESY, PhD-student): WP2, WP5

- Studies of SiPMs for HCAL Outer Ring 0
- Participation in the DESY activities for the CMS HCAL upgrade concerning the operation of the SiPM sensors

Dr. Ekaterina Kuznetsova (DESY, Postdoc): WP4

- Construction of a test stand for μ TCA
- μ TCA development

Erik Dietz-Laursonn (RWTH Aachen, Phd-student): WP2, WP6

- Development and integration of proto-types for the CMS-MTT project
- Analysis of CMS data with SiPMs in HCAL Outer
- Maintenance and simulations with the GEANT4 software package

Dr. Shaojun Lu (DESY fellow): WP7

- Preparation and operation of calorimeter beam tests
- Test beam data analysis

Clemens Günther (DESY, PhD-student): WP7

- Beam tests with tungsten structures and SiPMs and data analysis

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12 **Please describe the division of tasks (work packages WP1, WP2,... and milestones MS1, MS2,...) between the Helmholtz and the Russian researchers, including an estimate of working hours:**

WP1: Physics Analysis

German Research tasks:

- CMS physics analysis: search for Supersymmetry with data taken until end of 2013 (4400h)

Russian Research tasks:

- Phenomenology: Calculations of matrix elements for SUSY searches at LHC (1600h) and LC (1600h)
- Analysis of hadron production at colliders (4000h)
- Analysis of jet shapes and properties (1000h)
- Search for Higgs boson decaying into two tau leptons (4000h)

MS1:

- Publication of results of SUSY searches (conference contributions mid 2012, mid 2013, mid 2014, and contributions to papers end 2012, end 2013 and end 2014)
- Contribution to SUSY paper(s) by providing matrix element calculations (end 2013 and end 2014)
- Contribution to paper on jet shapes (end 2012)
- Paper on phenomenological study of hadron production at high energy (mid 2013)
- Contribution to paper on search for Higgs boson decaying into two tau leptons (end 2014)

WP2: CMS detector performance studies:

German Research tasks:

- Analysis of CMS data with existing SiPM sensors in the HO (400h)
- Monte Carlo generator implementations (400h)
- Improvement of software by including improved HO into jet reconstruction (400h)
- Simulations for SUSY analysis including improved HO (400h)

Russian Research tasks:

- Analysis of CMS data with emphasis on energy reconstruction with presently installed SiPMs (1000h)

MS2:

- Implementation of the SiPM sensor system into the CMSSW Monte Carlo simulation (end 2012)
- Implementation of the new software package, which includes new MET calculation into analysis code for SUSY analyses (end 2013)
- Results for improvement of using the software from for SUSY analyses (mid 2014)
- CMS analysis note including SiPMs that are already installed (end 2014)

WP3: Development for CMS detector upgrade – SiPM:

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German Research tasks:

- Construction of a complete CMS HCAL SiPM readout test stand (1200h)
- Optimizing operation and monitoring of SiPM sensors (1600h)
- SiPM sensor characterization (800h)

Russian Research tasks:

- Development of light mixers (1000h)
- SiPM sensor characterization (1000h)

MS3:

- Completion of test stand for SiPMs (mid 2012)
- Characterization of SiPM sensors (end 2012)

WP4: Development for CMS detector upgrade – μ TCA:**German Research tasks:**

- Participation in the upgrade of the readout systems towards μ TCA (1600h)
- Implementation of the μ TCA system into the slow control system and into the data acquisition system (2000h)

Russian Research tasks:

- Micro-electronics/electronics development and production of electronic boards for the μ TCA readout chain (2500h)
- Software/firmware development for μ TCA (2500h)

MS4:

- Prototype for the readout-upgrade with μ TCA ready (end 2012)
- Test stand for the integration of the μ TCA technology at DESY at MSU and at CERN (end 2012)
- Software for Slow Control via μ TCA developed (end 2013)
- Full functionality of current HCAL slow control available for μ TCA system (end 2013)
- μ TCA systems fully integrated into central Detector Control System (end 2014)
- μ TCA crates fully included into data acquisition chain, data from μ TCA crates available offline (end 2012)
- Final interfaces component - central DAQ in operation (end 2013)
- Ready to move all HCAL to μ TCA (end 2014)

WP5: CMS HCAL upgrade:**German Research tasks:**

- Implementation of SiPMs into CMS HO Ring 0 during shutdown 2013/2014 (1600h)
- Provide link person to the CMS integration to ease and control the needed complex modification work (400h)
- Construct a test stand for μ TCA in the test area at CERN and it take it into operation

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- Contribute to the installation of μ TCA components in the CMS experiment

Russian Research tasks:

- Production of light mixers (1000h)
- Assembly of light mixers/SiPM readout (1000h)

MS5:

- Production of light mixers (mid 2012)
- Assembly of light mixers/SiPM readout (mid 2013)
- SiPMs implemented into CMS HO Ring 0 (end 2013)

WP6: Development and integration of prototypes for the CMS MTT

German Research tasks:

- Design optimization and development of MTT prototype tiles (800h)
- Feasibility studies (800h) and setup of a trigger link from HO to the muon trigger (500h)
- Installation and test of an MTT prototype within the HO phase 1 upgrade (700h)
- Muon triggering and physics studies, especially with the installed HO SiPMs (800h)
- Integration of promising MTT prototypes into a test system (800h)

MS6:

- MTT prototype tiles developed (end 2013)
 - Studies for trigger link from HO to the muon trigger finished (end 2013)
 - Setup of a trigger link from HO to the muon trigger (end 2014)
 - MTT prototype installed (end 2014, then testing until end 2016)
 - Muon triggering and physics studies, especially with the installed HO SiPMs (end 2016)
 - Integration of promising MTT prototypes into a test system (end 2017)
- (The last items are out of the timescale of this Joint Research Group, but added to show the long term goals of the project.)

WP7: LC HCAL development

German Research tasks:

- Development of integrated read-out and calibration electronics boards (800h)
- Preparation and operation of calorimeter beam tests with various absorber structures (600h)
- Analysis of test beam data and hadronic shower reconstruction (1200h)

Russian Research tasks:

- Analysis of test beam data and hadronic shower reconstruction (6000h)
- Optimization of tile geometry with WLS fiber; detailed study of saturation curves (600 h)
- Development of scintillator tile geometry for direct readout (3000h)
- Development of new SiPM with improved dynamic range (3000h)

MS7:

- Production of light mixers (mid 2012)
- Optimization of tile geometry with WLS fiber (mid 2012)

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- Characterization of SiPM sensors (end 2012)
- Beam tests of integrated calorimeter modules with WLS fibre coupled tiles (end 2012)
- Assembly of light mixers/SiPM readout (mid 2013)
- Scintillator tiles for direct read-out (end 2013)
- Beam tests with hadron showers and direct read-out tiles (end 2014)
- New SiPM with improved dynamic range (end 2014)

13 Please describe the expected results of the project (e.g. anticipated publications):

LHC:

- Discover or set tighter exclusion limits for SUSY and other new physics beyond the Standard Model
- Description and interpretation of hadron production at colliders
- Measurement and interpretation of jet shapes at LHC
- Characterization and performance studies of SiPM sensors
- Experience with the new μ TCA readout on a large scale

Phenomenology and theory:

- Calculation of matrix elements for the production of new particles at hadron colliders in order to distinguish between different new physics (especially SUSY) models
- Development of a simulation system for LC physics for going from the theory model Lagrangian to detector signals

LC:

- Characterization, performance studies and optimization of SiPM sensors
- Hadronic calorimeter design for the LC
- Results from test beam measurements for a hadronic calorimeter at the LC
- New algorithms for the reconstruction of hadronic showers

14 Please describe how the project might lead to other funding opportunities in bilateral or multilateral programmes, such as the EC Framework Programme:

Applications for funding of detector upgrades for the future LHC, which requires R&D for radiation hard detector developments are in preparation.

The detector R&D for the LC makes use of infrastructure provided by the EU-funded EUDET initiative. This prepared the ground for participation in a future EU project for LC detector development within the FP7 programme called AIDA.

For parts of the proposed activities funding was approved already by another source, the Landesexcellence Hamburg, which enabled the investment for 1000 SiPM, needed for HO Ring 0 and for an initial test stand for optical studies.

The LC and LHC physics research in Russia is partially supported by the Ministry of Education and Science.

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A successful progress in the MTT project is expected to lead to further funds in the next funding period for universities.

For the young scientists in this HRJRG a number of suitable fellowships and grants will be opened, for example in the framework of the Marie-Curie Initial Training Network, once having acquired an outstanding profile as high energy physicist by finishing the activities in the proposed HRJRG. The former Joint Research Group (HRJRG-002) resulted in longer-term employments of several members in recognized international research institutes and universities.

PERSONALIA CONTINUED

- 15 **Please provide names and contact information of the Russian participating researchers per institute.**
Please give short resumes of the Russian participating researchers (including publications):

Institute 1

Institute name nr.1: **Institute for Theoretical and Experimental Physics (ITEP)**
Principal Investigator: Dr. Roman Mizuk gender: male
Phd-title ("kandidat nauk") obtained (mm/yy): 04/06
 Institute Address, telephone/fax number and e-mail address:
 ITEP, Bolshaya Cheremushkinskaya, 25, 117218 Moscow, Russia,
 +7 499 1253297 / +7 495 9139592, mizuk@itep.ru

Resume (max. 0.5 pages):

1996-1999: PhD student at Moscow Institute for Physics and Technology (MIPT)
 1999-present: Engineer, Scientist, Senior Scientist at ITEP
 2000-2003: Detector Subsystem Coordinator at HERA-B (High-pT Pre-trigger)
 2002-2003: Run Coordinator at HERA-B
 2005: Alikhanov's fellow
 2006-present: Teaching at Particle Physics Department of MIPT
 2007-2010: Principal Investigator at HRJRG-002
 2010: Lecturer at ITEP Winter School
 Gave more than 20 talks at international conferences including plenary talk at Symposium for Lepton-Photon Interactions in 2007.
 Member of BELLE, BELLE2, DANSS (reactor neutrino) and CALICE collaborations.
 Present interests are development of the scintillator-SiPM technology for particle detectors and physics analysis.

Recent publications (max. 0.5 pages):

Co-author of about 350 papers.
 1. I.Adachi et al. [Belle Collaboration], "Observation of two charged bottomonium resonances," [arXiv:1105.4583 [hep-ex]].

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2. I.Adachi et al. [Belle Collaboration], "First observation of the $h_b(1P)$ and $h_b(2P)$ bottomonium states," [arXiv:1103.3419 [hep-ex]].
3. C.Adloff et al. [CALICE Collaboration], "Electromagnetic response of a highly granular hadronic calorimeter," JINST6, P04003 (2011).
4. C.Adloff et al. [CALICE Collaboration], "Construction and Commissioning of the CALICE Analog Hadron Calorimeter Prototype ", JINST 5, P05004 (2010).
5. R.Mizuk et al. [Belle Collaboration], "Dalitz analysis of $B \rightarrow K \pi \psi'$ decays and the $Z(4430)^+$ ", Phys.Rev. D80, 031104 (2009).
6. R.Mizuk et al. [Belle Collaboration], "Observation of two resonance-like structures in the $\pi^+ \chi_{c1}$ mass distribution in exclusive $B^0 \rightarrow K^- \pi^+ \chi_{c1}$ decays", Phys.Rev. D78, 072004 (2008).
7. R.Mizuk et al. [Belle Collaboration], "Experimental constraints on the spin and parity of the $\Lambda_{c1}(2880)$ ", Phys.Rev.Lett. 98, 262001 (2007).
8. B.Dolgoshein et al. [CALICE Collaboration], "Status report on silicon photomultiplier development and its applications," Nucl. Instrum. Meth. A563, 368 (2006).
9. V.Balagura et al., "Study of scintillator strip with wavelength shifting fiber and silicon photomultiplier," Nucl. Instrum. Meth. A564, 590 (2006).
10. R.Mizuk et al. [Belle Collaboration], "Search for the $\Theta(1540)^+$ pentaquark using kaon secondary interactions at Belle", Phys.Lett.B 632, 173 (2006).

Key Researchers institute nr.1 (no more than 2):

Prof. Dr. Michael Danilov

gender: male

Telephone and e-mail addresses:

MD: +7-499-1253297 danilov@itep.ru

Resumes (max. 0.5 pages each):

1978: PhD

1990: Doctor of Science

1997 – present: Corresponding Member of the Russian Academy of Science since

2001 – present: ITEP research director

Professor at the Moscow Institute for Physics and Technology (Chair on Particle Physics)

Participated in ARGUS, H1, HERA-B and BELLE experiments and various detector R&D,

Member of the DESY Extended Scientific Council,

Member of the organizing Committee of the World Wide Study of Physics and Detectors for Linear Colliders,

Member of the Scientific and Technical Committee of the Russian Ministry of Atomic Energy,

Chairman of its subcommittee,

Member of the Editorial Board of the Russian Journal of Nuclear Physics,

Served for Program Advisory Committees for many international Conferences,

Director of 7 ITEP Schools.

Recent publications (max. 0.5 pages each):

Co-author of more than 200 scientific publications. A few recent papers:

1. C.Adloff et al. [CALICE Collaboration], "Electromagnetic response of a highly granular hadronic calorimeter," JINST6, P04003 (2011).

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2. T.Buanes et al. [CALICE Collaboration], "The CALICE hadron scintillator tile calorimeter prototype," Nucl. Instrum. Meth. A623, 342 (2010).
3. C.Adloff et al. [CALICE Collaboration], "Study of the interactions of pions in the CALICE silicon-tungsten calorimeter prototype," JINST 5, P05007 (2010).
4. C.Adloff et al. [CALICE Collaboration], "Construction and Commissioning of the CALICE Analog Hadron Calorimeter Prototype ", JINST 5, P05004 (2010).
5. C.Adloff et al. [CALICE Collaboration], "Response of the CALICE Si-W electromagnetic calorimeter physics prototype to electrons," Nucl. Instrum. Meth. A608, 372 (2009).
6. J.Repond et al. [CALICE Collaboration], "Design and Electronics Commissioning of the Physics Prototype of a Si-W Electromagnetic Calorimeter for the International Linear Collider," JINST 3, P08001 (2008).

Young scientists institute nr.1:

Alexander Bylinkin	gender: male
Oleg Markin	gender: male
Maria Erofeeva	gender: female

Telephone and e-mail addresses:

+7-499-7896646, +7-499-1270572, +7-499-7896646,
xander-snz@rambler.ru, markin@itep.ru, m.a.erofeeva@gmail.com

Resumes (max. 0.5 pages):

AB:

Presently working at ITEP and at the same time diploma student at Moscow University for Physics and Technics; since 2009 member of the H1 collaboration.

Field of interest:

Phenomenological analysis of the experimental data on hadron production and QCD dynamics.

OM:

1989-1994: Engineer, Junior Scientist at ITEP

2008-present: Scientist at ITEP

Working on analysis of test beam data and development of hadronic shower reconstruction algorithms.

Talk at CALOR2010.

Field of interest:

Reconstruction of hadronic showers, applications of SiPMs.

ME:

Presently working at ITEP as PhD student.

Since 2010 member of the CMS collaboration.

2010 Summer student at DESY

Field of interest:

Hadronic jet production at LHC.

Recent publications (max. 0.5 pages):

AB:

1. A. A. Rostovtsev, A. A. Bylinkin, "Systematic studies of hadron production spectra in collider experiments", <http://arxiv.org/abs/1008>.

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2. H1 Collab., "Measurement of the Inclusive ep^{++} Scattering Cross Section at High Inelasticity y and of the Structure Function FL ", Eur.Phys.J.C71 (2011) 1579 , 12/10

OM:

C.Adloff et al., "Construction and Commissioning of the CALICE Analog Hadron Calorimeter Prototype ", JINST 5, P05004 (2010).

ME: publication in preparation.

Institute 2

Institute name nr.2: **Moscow State University (SINP MSU)**

Group Leader: Dr. Artem Lipatov

gender: male

Phd-title ("kandidat nauk") obtained (mm/yy): 04/04

Institute Address, telephone/fax number and e-mail address:

Lomonosov Moscow State University, Skobeltsyn Institute of Nuclear Physics (MSU SINP),
1(2), Leninskie Gory, GSP-1, Moscow 119991, Russian Federation
+7 495 939 3064 / +7 495 939 3064
lipatov@theory.sinp.msu.ru

Resume (max. 0.5 pages):

2004 : PhD at D.V. Skobeltsyn Institute of Nuclear Physics, M.V. Lomonosov MSU

2004-present: SINP MSU staff Research Scientist.

Fellowships and Grants:

INTAS YSF 2002-2004,

Russian Foundation for Basic Research 2002-2003, 2008-2009,

Dynasty Foundation 2003-2004,

Russian Federation Presidential grant for Excellent Young Scientists 2006-2009, 2011-2012

Moscow-DESY project on MC implementation for HERA-LHC 2008-2011,

SINP MSU Fellowship for Young Scientists 2007, 2009,

MSU Fellowship for Young Researchers 2006, 2008, 2010

Scientific interests: phenomenology and simulations, mainly concentrated in small-x physics, investigating the details of the small-x evolution of parton densities using the different processes (like heavy quark, prompt photon and other productions) at high energies.

Recent publications (max. 0.5 pages):

Dr. Artem Lipatov has about 30 publications. Most recent:

1. A.V. Lipatov, M.A. Malyshev, N.P. Zotov, «Testing for kt-factorization with inclusive prompt photon production at LHC», Phys. Lett. B 699, 93 (2011).
2. H. Jung, M. Kraemer, A.V. Lipatov, N.P. Zotov, «Heavy Flavour Production at Tevatron and Parton Shower Effects », JHEP 1101, 085 (2011).
3. H. Jung et al, «The CCFM Monte Carlo generator CASCADE 2.2.0», Eur. Phys. J. C 70, 1237 (2010).
4. S.P. Baranov, A.V. Lipatov, N.P. Zotov, "Deep inelastic prompt photon production at HERA in the kt-factorization approach ", Phys. Rev. D 81, 094034 (2010).
5. A.V. Lipatov, N.P. Zotov, "Study of non-collinear parton dynamics in the prompt photon photoproduction at HERA", Phys. Rev. D 81, 094027 (2010).
6. A.V. Lipatov, N.P. Zotov, "Associated production of Higgs boson and heavy quarks at the LHC:

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Helmholtz Russia Joint Research Group

predictions with the kt-factorization", Phys. Rev. D 80, 013006 (2009).

7. A.V. Lipatov, N.P. Zotov, "On the quark component in prompt photon and electroweak gauge boson production at high energies", J. Phys. G 36, 125008 (2009).
8. S.P. Baranov, A.V. Lipatov, N.P. Zotov, "Production of electroweak gauge bosons in off-shell gluon-gluon fusion", Phys. Rev. D 78, 014025 (2008).
9. A.V. Lipatov, N.P. Zotov, "Beauty production in two-photon interactions at LEP2: kt-factorization versus data", JETP Lett. 87, 7 (2008).
10. S.P. Baranov, A.V. Lipatov, N.P. Zotov, "Prompt photon hadroproduction at high energies in off-shell gluon-gluon fusion", Phys. Rev. D 77, 074024 (2008).
11. A.V. Lipatov, N.P. Zotov, "Charm photoproduction at HERA: kt-factorization versus experimental data", Phys. Rev. D 75, 014028 (2007).

Key Researchers institute nr.2 (no more than 2): **SINP MSU**

Prof. Dr. Eduard Boos gender: male

Dr. Michael Merkin gender: male

Telephone and e-mail addresses:

+7 495 939 3064 email: boos@theory.sinp.msu.ru, merkinm@silab.sinp.msu.ru

Resumes (max. 0.5 pages):

EB:

Education:

1984: Ph.D. in Theoretical and Mathematical Physics (Candidate of Physics and Mathematics Science, degree in Russia);

1991: Second Dissertation in Theoretical Physics (Doctor of Physics and Mathematics Science, degree in Russia)

Employment:

1981-1984: Postdoc, Institute for High Energy Physics, Protvino, Moscow Region, Russia;

1984-present: SINP MSU staff Scientist:

1991-present: Head of the Laboratory "Theories of Fundamental Interactions" in the SINP MSU High Energy Theory Division;

1999-present: Professor at the MSU Physics Department;

2008-present: Head of High Energy Experimental Physics Division, SINP MSU

1997-1998: Visitor Professor at the Institut für Kernphysik, Technische Universität Darmstadt;

2004: Visitor Professor at the Fermilab Theoretical Physics Department;

Memberships in Scientific Associations: the CompHEP Group, D0 Collaboration (Fermilab); ILC Collaboration; CMS (CERN);

Awards: 2002: Bessel Research Award of Humboldt Foundation

Main Research Interests at present:

Theoretical and Experimental High Energy Physics, Collider Phenomenology, Automatic Computations in High Energy Physics

MM:

1987: PhD

1980-1990: Engineer, Scientist, Senior Scientist, - microelectronic firm "MION", Tbilisi, Georgia.

1991-2003: Senior Scientist, Silicon Detector Laboratory, Experimental High Energy Physics Department, SINP MSU

2003-present: Head of Silicon Detector Laboratory, Experimental High Energy Physics

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Department SINP MSU

Member of ZEUS at DESY, LHCb at CERN, CBM at GSI, D0 at FNAL, NUCLEON (satellite), SVD-2 at ITEP Protvino, CLAS12 at JLAB

Designed more than 20 different types of silicon sensors for high energy physics experiments, worked on radiation hardness of microelectronic.

Recent publications (max. 0.5 pages):

EB: selection of few recent publications:

1. V.M.Abazov et al. [D0 Collaboration], "Search for flavor changing neutral currents via quark-gluon couplings in single top quark production using 2.3 fb^{-1} of ppbar collisions", Phys. Lett. B 693 (2010) 81.
2. E.E.Boos, V.E.Bunichev, L.V.Dudko, A.A.Markina and M.A.Perfilov, "Optimization of the analysis of single top-quark production at the Large Hadron Collider (LHC) ", Phys.Atom.Nucl. 73, 971 (2010), Yad.Fiz.73, 1007 (2010)].
3. E.E.Boos, S.V.Demidov and D.S.Gorbunov, "Invisible Higgs in weak bosons associative production with heavy quarks at LHC: probing mass and width", PoS QFTHEP2010 (2011) 026 [arXiv:1010.5373 [hep-ph]
4. V.Khachatryan et al. [CMS Collaboration], "First Measurement of the Cross Section for Top-Quark Pair Production in Proton-Proton Collisions at $\sqrt{s}=7 \text{ TeV}$ ", Phys.Lett. B 695(2011) 424.
5. V.Khachatryan et al. [CMS Collaboration], "Search for Supersymmetry in pp Collisions at 7 TeV in Events with Jets and Missing Transverse Energy", Phys.Lett. B698 (2011) 196.
6. E.E.Boos and M.N.Dubin, "Problems of automatic calculation for collider physics", Phys.Usp. 53 (2010) 1039 Usp.Fiz.Nauk 180 (2010) 1081.
7. V.M.Abazov et al. [D0 Collaboration], "Measurement of the t-channel single top quark production cross section", Phys. Lett. B 682 (2010) 363.
8. E.Boos et al., "CompHEP 4.5 Status Report", PoS ACAT08 (2009) 008
9. V.M.Abazov et al. [D0 Collaboration], "Search for anomalous top quark couplings with the D0 Detector", Phys. Rev. Lett. 102 (2009) 092002
10. E.E.Boos, V.Bunichev, H.J.Schreiber, "Prospects of a Search for a New Massless Neutral Gauge Boson at the ILC", Phys. Rev. D78 (2008) 015007
11. E.E.Boos et al., "Method for simulating electroweak top-quark production events in the NLO approximation: Single Top event generator", Phys. Atom. Nucl. 69 (2006) 1317 [Yad. Fiz. 69 (2006) 1352].

MM: has more than 400 publications. Some of them, concerning calorimetry:

1. Kh.U. Abraamyan et al., "The MPD detector at the NICA heavy-ion collider at JINR", Nucl.Instrum.Meth.A628:99-102,2011
2. S.N. Ahmed et al. , "The D0 Silicon Microstrip Tracker", Nucl.Instrum.Meth.A 634:8-46,201
3. C. Adloff et al (CALICE Collaboration), "CALICE Report to the DESY Physics Research Committee", 2010. 53pp. e-Print: arXiv:1003.1394 [physics.ins-det]
4. E.V. Atkin et al., "New High-Energy cosmic-Ray Observatory (HERO) project for studying the high-energy primary cosmic-ray radiation", Nucl.Phys.Proc.Suppl.196:450-453,2009.
5. E. Atkin, et al., "Integrated Circuit Readout for the Silicon Sensor Test Station", arXiv:0906.2063
6. Adloff et al., "Response of the CALICE Si-W electromagnetic calorimeter physics prototype to electrons.", Nucl.Instrum.Meth.A608:372-383,2009.
7. S.G. Basiladze et al., "Electronic equipment for readout and processing of data from the

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Helmholtz Russia Joint Research Group

microstrip vertex detector of the SVD-2 setup", Instrum.Exp.Tech.49:350-357,2006, Prib.Tekh.Eksp.49:61-68,2006.

8. C. Adloff et al., "Study of the interactions of pions in the CALICE silicon-tungsten calorimeter prototype", arXiv:1004.4996 [physics.ins-det]
9. S.N. Ahmed et al., "The D0 Silicon Microstrip Tracker", FERMILAB-PUB-10-101, May 2010, arXiv:1005.0801.
10. E.V. Atkin et al., "New High-Energy cosmic-Ray Observatory (HERO) project for studying the high-energy primary cosmic-ray radiation", Nucl.Phys.Proc.Suppl.196:450-453,2009.
11. F. Campabadal et al., "Beam tests of ATLAS SCT silicon strip detector modules", Nucl.InstrumMeth.A538:384-407,2005.

Young scientists institute nr.2:

Ilya Kudryashov

gender: male

Maxim Malyshev

gender: male

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+7 495 939 3064 ilya.kudryashov@cern.ch, malyshev@theory.sinp.msu.ru

Resumes (max. 0.5 pages):

IK:

PhD student SINP MSU

2008: M.Sc. in Physics at Physics Department of Lomonosov Moscow State University. Diploma thesis on study of aging mechanism in the gas detectors (Diploma with honours)

March 2008 - present: PhD student at Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University.

Current task: development of the readout electronics for the silicon detectors for collider experiments in high-energy physics.

MM:

PhD student of Physics Department of Lomonosov Moscow State University

February 2011: Diploma at Physics Department of Lomonosov Moscow State University (Scholarship as an advanced student)

Feb.2011 - present: PhD student of Physical Department of Lomonosov Moscow State University
Diploma thesis is based on a phenomenological analysis.

Scientific interest on LHC phenomenology and Monte Carlo generator development

Publications (max. 0.5 pages):

IK:

1. R. Aaij et al. (LHCb Collaboration), "Measurement of $\sigma(pp \rightarrow b \text{ anti-}b X)$ at $\sqrt{s}=7$ TeV in the forward region", CERN-PH-EP-2010-029, Phys.Lett.B694:209-216,2010.
2. R. Aaij et al. (LHCb Collaboration), "Prompt K_{short} production in pp collisions at $\sqrt{s}=0.9$ TeV", CERN-PH-EP-2010-027, Phys.Lett.B693:69-80,2010.
3. R. Aaij et al. (LHCb Collaboration), "Roadmap for selected key measurements of LHCb", LHCb-PUB-2009-029, Dec 2009. 379pp.
4. A. Aleev et al. (SVD Collaboration), "New analysis on narrow baryon resonance decaying into $pK^0(s)$ in pA-interactions at 70-GeV/c with SVD-2 setup", arXiv:0803.3313 [hep-ex]

JOINT RESEARCH PROPOSAL

Helmholtz Russia Joint Research Group

5. E. V. Atkin,, et al., "Read-out ASIC for Microstrip Detectors", DOI: 10.1134/S1063739711010021

MM:

1. A.V. Lipatov, M.A. Malyshev, N.P. Zotov, "Testing for kt-factorization with inclusive prompt photon production at LHC", Phys. Lett. B 699, 93 (2011).

- 16 **Please give the names and contact information of the participating Helmholtz researchers per institute**
Please give short resumes of the Helmholtz participating researchers (including publications):

Institute 1

Institute name nr.1: Deutsches Elektronen-Synchrotron

Principal Investigator: Dr. Isabell-Alissandra Melzer-Pellmann gender: female

Institute Address, Telephone/Fax Number and e-mail address:

Notkestr. 85, 22605 Hamburg, +49 40 8998 2489/3032, isabell.melzer@desy.de

Resume (max. 0.5 pages):

2001: PhD at the University of Mainz,

2001-2004: DESY fellow (ZEUS),

2004-2009: DESY Postdoc (Test Beam DESY II, ILC),

2009-present: Helmholtz-University Young Investigator Group Leader at DESY and Hamburg

University, Topic: Supersymmetry at the Terascale

1997-1998 member of COSY 11 (Jülich), 1998-2001 member of NA48 (CERN), since 2002 member of ZEUS (DESY), 2006-2008 work on ILC, since 2009 member of CMS

Current field of interest is Supersymmetry and Hadron Calorimeters

Recent publications (max. 0.5 pages):

1. Serguei Chatrchyan et al. [CMS Collaboration], "Search for supersymmetry in events with a lepton, a photon, and large missing transverse energy in pp collisions at $\sqrt{s} = 7$ TeV. CMS-SUS-11-002, CERN-PH-EP-2011-058, May 2011, arXiv:1105.3152 [hep-ex]
2. Serguei Chatrchyan et al. [CMS Collaboration], "Search for new physics with same-sign isolated dilepton events with jets and missing transverse energy at the LHC", CMS-SUS-10-004, CERN-PH-EP-2011-033, Apr 2011. 40pp, arXiv:1104.3168 [hep-ex]
3. Serguei Chatrchyan et al. [CMS Collaboration], "Search for Supersymmetry in pp Collisions at $\sqrt{s} = 7$ TeV in Events with Two Photons and Missing Transverse Energy", CERN-PH-EP-2011-007
4. Vardan Khachatryan et al. [CMS Collaboration], "Search for Supersymmetry in pp Collisions at 7 TeV in Events with Jets and Missing Transverse Energy", Phys.Lett.B698:196-218, 2011
5. I.-A. Melzer-Pellmann, "Study of beam-beam effects with offset and angle scans", EUROTeV-Report 2007, S. 21
6. T. Behnke et al., "Test Beams at DESY", EUDET-Memo 2007
7. ZEUS Collaboration, "Diffractive photoproduction of $D^*\pm(2010)$ at HERA", Eur. Phys. J. C51, 2007, S. 301-315
8. I.-A. Melzer-Pellmann, "Diffractive interactions in ep collisions", Proceedings of the Photon2005,

JOINT RESEARCH PROPOSAL

Helmholtz Russia Joint Research Group

Acta Phys. Polon. B37, 2006. S. 811–818

9. I.-A. Melzer-Pellmann, "H1 and ZEUS Results on Beauty Production", Proceedings of the 39th Rencontres de Moriond on QCD and High Energy Hadronic Interactions, 2004
10. I. Bloch et al., "A radiation Monitor for the ZEUS Detector at HERA", IEEE Trans. Nucl. Sci. 51, 2004. S. 1606–1612

Key Researchers institute nr.1 (no more than 2):

Dr. Kerstin Borras	gender: female
Dr. Felix Sefkow	gender: male

Telephone and e-mail addresses:

KB: +49 40 8998 4488, kerstin.borras@desy.de

FS: +49 40 8998 3402, felix.sefkow@desy.de

Resumes (max. 0.5 pages):

KB:

1992 PhD, 1992-1996 scientific assistant University Dortmund, since 1999 DESY staff
Experiment member of H1 (<1999), CDF(1997–2004), ZEUS (>1999), CMS (>2006)
fellowships: Foundation of the German Nation (Studienstiftung des Deutschen Volkes),
Max-Kade Grant for research visit of one year at Rockefeller University New York,
Lise-Meitner Habilitation Grant of Nordrhein Westfalen (1/2y then DESY staff)
Member of the LHC Committee 2002-2005, responsible for LHCb and TOTEM experiments
Coordinator of the calorimeters in H1 (1994) and in ZEUS (1999-2006)
Coordinator of working group "Diffraction and Vector Meson Production" in ZEUS (2002-2005)
Project Leader for the CASTOR Calorimeter in CMS since 2007 (with funding from HRJRG-002)
Member of the Collaboration Board, HCAL Steering Committee, Finance Board in CMS (since 2008)
Member of the CMS Conference Committee (since June 2010)
Deputy leader of the DESY-ZEUS group (2006-2010)
Leader of the DESY-CMS group (since 2008, growing group, now ~75 members)
Principal Investigator of a Helmholtz-Russia Joint Research Group (HRJRG-002, 2007-2010)
Topic speaker for LHC in the Helmholtz Program Elementary Particle Physics
Principal Investigator in the Landesexcellence Hamburg

FS:

Studienstiftung fellow, PhD in 1990, CERN and DESY Fellow, Assistant professor at Zurich University, DESY staff scientist since 2002, member of ARGUS, ALEPH, H1 and CALICE collaborations, coordinator of H1 physics and detector working groups, presently CALICE Collaboration spokesperson and HCAL project leader, EUDET coordinator, AIDA task leader, European convenor for ILC calorimetry.

Selected publications (max. 0.5 pages):

KB:

1. S. Chekanov et al. [ZEUS Collaboration], "Leading Neutron Energy and P_T Distributions in Deep Inelastic Scattering and Photoproduction at HERA", DESY-07-011 (January 2007), published online in Physics Letters B.
2. K. Borras, et al., "An Improved weighting algorithm to achieve software compensation in a fine

JOINT RESEARCH PROPOSAL

Helmholtz Russia Joint Research Group

grained LAr calorimeter", Nucl.Instrum.Meth.A545:803-812,2005

3. T. Affolder et al. [CDF Collaboration], "Dijet production by double pomeron exchange at the Fermilab Tevatron", Phys.Rev.Lett.85:4215-4220,2000
4. T. Affolder et al. [CDF Collaboration], "Diffractive dijets with a leading anti-proton in anti-p p collisions at $S^{*}(1/2) = 1800\text{-GeV}$ ", Phys.Rev.Lett.84:5043-5048,2000
5. C. Adloff et al. [H1 Collaboration], "Hadron production in diffractive deep inelastic scattering", Phys.Lett.B428:206-220,1998.
6. B. Andrieu et al. [H1 Calorimeter Group], "Beam tests and calibration of the H1 liquid Argon calorimeter with electrons", Nucl.Instrum.Meth.A350:57-72,1994.

FS:

1. F.Sefkow and C.Zeitnitz, "Calorimetry: Precise energy measurements", in: Physics at the Terascale, eds. I.Brock, T.Schoerner-Sadenius, Wiley, 2011.
1. CALICE collaboration, Construction and Commissioning of the CALICE Analog Hadron Calorimeter Prototype, JINST 5:P05004,2010.
2. V. Andreev et al. A high granularity scintillator hadronic-calorimeter with SiPM readout for a linear collider detector, Nucl.Instrum.Meth.A540:368-380,2005
3. F.Sefkow, Performance goals and design considerations for a linear collider calorimeter, in Perugia 2004, Calorimetry in particle physics* 435-444
4. F.Sefkow, Open beauty production, J.Phys.G28:953-970,2002
5. C. Adloff et al [H1 Collaboration], Measurement of D^* meson cross-sections at HERA and determination of the gluon density in the proton using NLO QCD, Nucl.Phys.B545:21-44,1999
6. D. Buskulic et al. [ALEPH Collaboration], Observation of the time dependence of $B(d)0$ - anti- $B(d)0$ mixing, Phys.Lett.B313:498-508,1993
7. H. Albrecht et al [ARGUS Collaboration], Measurement of the lifetime ratio $\tau(B^+) / \tau(B^0)$, Phys.Lett.B232:554,1989

Young scientists institute nr.1:

Dr. Benjamin Lutz	gender: male
Dr. Ekaterina Kuznetsova	gender: female
Dr. Shaojun Lu	gender: male
Jakob Salfeld-Nebgen	gender: male
Clemens Günther	gender: male

Telephone and e-mail addresses:

BL:	+49 40 8998 1502,	benjamin.lutz@desy.de
EK:	+49 40 8998 3569	ekaterina.kuznetsova@desy.de
SL:	+49 40 8998 1641	shaojun.lu@desy.de
JS:	+49 40 8998 2997	jakob.salfeld@desy.de
CG:	+49 40 8998 4598,	clemens.guenther@desy.de

Resumes (max. 0.5 pages):

BL:

2006: Diploma 2006,

JOINT RESEARCH PROPOSAL

Helmholtz Russia Joint Research Group

2010: PhD within the CALICE collaboration

Member of the CALICE collaboration and of CMS, fellow of HRJRG-002

Postdoc since 8/2010, funded by Landesexcellence Hamburg, afterwards position as DESY fellow

EK:

2002-2006: DESY PhD student with ILC group and at the Humboldt University of Berlin

2002-2007: Junior scientific researcher at PNPI (Gatchina, Russia) at the Track Detector Department

2006-2008: INFN (Roma-I) PostDoc (ATLAS and ILC)

2008-present: DESY Postdoc (CMS)

SJ:

Studied physics in China, Phd in particle physics

2007 Phd in particle physics at Giessen University (HERMES collaboration),

Post-doc positions in detector R&D and data analysis at GSI Darmstadt and MPI, Munich, joined the DESY linear collider detector calorimeter group in 2009, CALICE software coordinator

JS:

PhD student, diploma in 2009, member of the CMS collaboration

CG:

PhD student, diploma in 2010, member of the CALICE collaboration

Recent publications (max. 0.5 pages):

BL: more than 16 publications as co-author with the CALICE Collaboration

1. S. Blin et al., "Dedicated very front-end electronics for an ILC prototype hadronic calorimeter with SiPM readout", LC-DET-2006-007, CERN-2008-008, „Naxos 2008, Electronics for particle physics" 97-106
2. N. D'Ascenzo et al., "CALICE scintillator HCAL commissioning experience and test beam program 2006", LC-DET-2006-009, <http://www-flc.desy.de/lcnotes/notes/LC-DET-2006-009.pdf>
3. R. Eisberg et al., "Fast and reasonable Installation, Experience and Acceptance of a Remote Control Room", 2008, arXiv:0811.3228.
4. B. Lutz, "Test Beam Results from the CALICE Tile Hadron Calorimeter Prototype with SiPM Read-Out", Nuclear Science Symposium Conference Record, NSS '08. IEEE, 2008
5. R. Fabbri, B. Lutz, W. Shen, "Overview of Studies on the SPIROC Chip Characterisation", 2009, arXiv:0911.1566
6. CALICE Collaboration, "Construction and commissioning of the CALICE Analog Hadron Calorimeter Proto-type", 2010 JINST 5 P05004, arXiv:1003.2662
7. CALICE Collaboration, "Electromagnetic response of a highly granular hadronic calorimeter", 2011 JINST 6 P04003, e-print arXiv:1012.4343

EK:

1. S. Gentile et al., "Measurements of photon detection efficiency of Geiger-mode avalanche photodiodes (G-APD)", Nuovo Cim. B125(2010)08
2. Ch. Grah et al., "Polycrystalline CVD diamonds for the beam calorimeter of the ILC", IEEE Trans. Nucl. Sci. 56:462-467, 2009
3. C. Bosio et al., "First results of systematic studies done with silicon photomultipliers", Nucl. Instrum. Meth. A596:134-137, 2008
4. A. Calcaterra et al., "Study of solid state photon detectors read out of scintillator tiles", proceedings of LCWS08 and ILC08, arXiv:0901.1759

JOINT RESEARCH PROPOSAL

Helmholtz Russia Joint Research Group

5. C. Bosio et al., "First results of comparative studies of silicon photomultipliers", Nuovo Cim.C30:529-533,2007

AF:

1. The CMS Collaboration, "Forward energy flow in the CMS detector", CMS PAS FWD- 10-011, 2011
2. The CMS Collaboration, "Measurement of the energy flow at large pseudorapidity at the LHC at $\sqrt{s} = 900, 2360$ and 7000 GeV, CMS PAS FWD-10-002, 2010
3. A. Floßdorf: Higher Order QCD Radiation in Top Pair Production with the CMS Detector, DESY-THESIS-2009-038, 2009

Institute 2

Institute name nr.2: Institute of Physics III A, RWTH Aachen University

Group Leader: Dr. Markus Merschmeyer gender: male

Institute Address, Telephone/Fax Number and e-mail address:

III. Physikalisches Institut A, RWTH Aachen University, Otto-Blumenthal-Str., 52074 Aachen,
+49 241 80 27274, +49 241 80 22189, merschm@physik.rwth-aachen.de

Resume (max. 0.5 pages):

2004: PhD at the University in Heidelberg,

2005-2007: Post-Doc at the University of Heidelberg

2007 – present: Scientist at RWTH Aachen University, Institute of Physics III A

Research topics:

1999 – 2000: PHENIX experiment, BNL, Brookhaven, USA

GEANT simulations of an electromagnetic calorimeter

2001 – 2007: FOPI experiment, GSI, Darmstadt, Germany

Measurement and analysis of multi-strange baryon production in heavy-ion collisions,

Development of fast data reduction algorithms for a DAQ system

2007 – present: CMS experiment, CERN, Geneva, Switzerland

Support and implementation of the SHERPA MC generator into the CMS software,

Detector development for the SLHC upgrade of the muon system

Recent publications (max. 0.5 pages): (more than 80 for CMS, FOPI and PHENIX as co-author)

1. S. Chatrchyan et al. [CMS Collaboration], "Measurement of the lepton charge asymmetry in inclusive W production in pp collisions at $\sqrt{s} = 7$ TeV", JHEP 1104, 050 (2011)
2. S. Chatrchyan et al. [CMS Collaboration], "Measurement of W+W- Production and Search for the Higgs Boson in pp Collisions at $\sqrt{s} = 7$ TeV", Phys. Lett. B 699, 25 (2011)
3. V. Khachatryan et al. [CMS Collaboration], "Measurement of B anti-B Angular Correlations based on Secondary Vertex Reconstruction at $\sqrt{s}=7$ TeV", JHEP 1103, 136 (2011)
4. M. Merschmeyer et al. [FOPI Collaboration], "K0 and Lambda production in Ni+Ni collisions near threshold", Phys. Rev. C 76, 024906 (2007)
5. M. Merschmeyer [FOPI Collaboration], "Strangeness production close to threshold", J. Phys. G 31, S1147 (2005)
6. K. Adcox et al. [PHENIX Collaboration], "Formation of dense partonic matter in relativistic nucleus-nucleus collisions at RHIC", Nucl. Phys. A 757, 184 (2005)
7. M. Merschmeyer [FOPI Collaboration], "Measurement of strange resonances with FOPI", Prog. Part. Nucl. Phys. 50, 583 (2003)

JOINT RESEARCH PROPOSAL

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8. A. Mangiarotti et al. [FOPI Collaboration], "Sub-threshold phi meson yield in central Ni-58 + Ni-58 collisions", Nucl. Phys. A 714, 89 (2003)
9. K. Adcox et al. [PHENIX Collaboration], "Centrality dependence of charged particle multiplicity in Au - Au collisions at $S(NN)^{1/2} = 130$ GeV", Phys. Rev. Lett. 86, 3500 (2001)

Young scientists institute nr.2:

Erik Dietz-Laursonn gender: male

Telephone and e-mail addresses:

III. Physikalisches Institut A, RWTH Aachen University, Otto-Blumenthal-Str., 52074 Aachen,
+49 241 80 27267, +49 241 80 22189, erik.dietz-laursonn@physik.rwth-aachen.de

Resumes (max. 0.5 pages):

2010: Diploma in Physics at RWTH Aachen University,

2011-present: PhD student

Research topics:

2009-2010: CMS experiment (CERN), model independent searches with b hadrons;

2011-present: studies of light transport in scintillation detectors, GEANT simulations of HCAL light mixers, development of detector prototypes with SiPMs

Publications (max. 0.5 pages):

S. Chatrchyan et al. [CMS Collaboration], "Measurement of the lepton charge asymmetry in inclusive W production in pp collisions at $\sqrt{s} = 7$ TeV", JHEP 1104, 050 (2011)

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Helmholtz Russia Joint Research Group

FINANCIAL SCHEME¹

17 Please list in detail the anticipated costs for consumables and equipment:

Equipment or consumable	Amount	Price per unit	Russian Group	Helmholtz group	Subtotal
Helmholtz funds			assigned to²	assigned to	
DESY - LHC					
SIPM Sensors	100	100		10,000	
Readout Teststand (μTCA)	3	12,000		36,000	
Consumables Testbeam	1	5,000		5,000	51,000
DESY-LC					
Readout Boards	60	1,000		60,000	60,000
RWTH Aachen					
MTT Prototype	1	19,600		19,600	19,600
Total					130,600
RFBR funds			assigned to	assigned to	
ITEP					
Spectrophotometer	1	14,000	14,000		
Casting form and material		10,000	10,000		
Consumables	1	5,300	5,300		
Overhead		11,250	11,250		40,550
MSU					
Readout Teststand (μTCA) + material	1	15,250	15,250		
Consumables		5,000	5,000		
Software	3	2,500	7,500		27,750
Total					68,300

¹ Section 17-21: Please adjust number of fields to your requirements.

² Consumables only; Helmholtz funds not eligible for equipment in Russia!

JOINT RESEARCH PROPOSAL

Helmholtz Russia Joint Research Group

 18 Please list in detail the travel and subsistence costs:

Visit	Name of traveller	Duration	Subsistence costs	Travel costs	Russian group	Helmholtz group	Subtotal
Helmholtz funds					assigned to	assigned to	
1	R. Mizuk	3x 7 days	0	3x 400	1,200		
2	M. Danilov	7 days	200	400	600		
4	A. Bylinkin	3x 1 month	0	400	1,200		
5	O. Markin	3x 1 month	0	400	1,200		
6	M. Erofeeva	3x 1 month	0	400	1,200		5,400
7	A. Lipatov	3x 1 month	3x 1,500	3x 400	5,700		
8	I. Kudryashov	2x 14 days	2x 750	2x 400	2,300		
9	M. Malyshev	1x 14 days 1x 22 days	1x 750 1x 1200	2x 400	2,750		10,300
10	I. Melzer-Pellmann	2x 7 days	2x 200	2x 800		2,000	
11	K. Borrás	2x 7 days	2x 200	2x 800		2,000	
12	F. Sefkow	2x 7 days	2x 200	2x 800		2,000	
13	B. Lutz	2x 7 days	2x 200	2x 800		2,000	
14	E. Kuznetsova	7 days	200	800		1,000	
15	J. Salfeld-Nebgen	2x 7 days	200	800		2,000	
16	S. Lu	7 days	200	800		1,000	
17	C. Guenther	7 days	200	800		1,000	13,000
18	M. Merschmeyer	7 days	2x 200	2x 800		2,000	
19	E. Dietz-Laursonn	7 days	2x 200	2x 800		2,000	4,000
Total							32,700
RFBR funds					assigned to	assigned to	
17	E. Boos	2x 14 days	2x 750	2x 400	2,300		
18	M. Merkin	2x 14 days	2x 750	2x 400	2,300		
19	A. Lipatov	14 days	750	400	1,150		
20	M. Malyshev	10 days	550	400	950		
Total							6,700

JOINT RESEARCH PROPOSAL

Helmholtz Russia Joint Research Group

19 **Please give a short comment on the anticipated visits mentioned in question 18:**

#1 - #9 – Russian guest scientists stay at Helmholtz Centre (funded by Helmholtz)

#10 -#19 – Helmholtz scientists visit in Russia (funded by Helmholtz)

#17 -#20 – Russian scientists participate in conference (funded by RFBR)

A kick-off workshop with all participants will take place in Russia at the start of the project.

A mid-term workshop again with all participants is planned to take place at DESY.

Regular video and phone conferences are scheduled to monitor the progress and to discuss possible problems.

It is expected that additional travel, if necessary, can be funded with other sources.

Travel costs for participants from DESY include the flight and the visa.

20 **Please list the anticipated working hours and individual grants with respect to Russian scientists:**

	Name	Hours spend on the project per month	Monthly Fee	Months	Subtotal
RFBR funds					
Total					0
Helmholtz funds					
Institute 1: ITEP					
Principal Investigator	R. Mizuk	134	500	36	18,000
Group leader	M. Danilov	50	0	36	
Young scientists					
1	A. Bylinkin	168	150	36	5,400
2	O. Markin	168	300	36	10,800
3	M. Erofeeva	168	150	36	5,400
Institute 2: MSU					
Group leader	A. Lipatov	168	600/0	28/8	14,000
Key researchers					
1	E. Boos	50	0	36	
2	M. Merkin	50	0	36	
Young scientists					
1	I. Kudryashov	84	400/0	30/6	12,000
2	M. Malyshev	84	300/0	29/7	8,700
Total					74,300

JOINT RESEARCH PROPOSAL

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21 **Please list the anticipated working hours and personnel costs with respect to Helmholtz scientists:**

	Name	Hours spend on the project per month	Monthly Fee	Months	Subtotal
DESY					
Principal Investigator	I. Melzer-Pellmann	80	0	36	
Key researchers					
1	K. Borras	40	0	36	
2	F. Sefkow	40	0	36	
Young scientists					
1	E. Kuznetsova	168	5,000	12	60,000
2	B. Lutz	168	0	24	
4	J. Salfeld-Nebgen	168	0/2,500	10/12	30,000
5	S. Lu	56	2,000	12	24,000
6	C. Guenther	56	1,000	12	12,000
RWTH Aachen					
Group leader	M. Merschmeyer	40	0	36	
1	E. Dietz-Laursonn	56	0/ 2,200	12 / 12	26,400
Total					152,400

JOINT RESEARCH PROPOSAL

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22 Give an overview of the total project costs (in accordance with "Scope of Funding", Call for Proposals):

	Russian group	Helmholtz group	Total
Helmholtz funds	assigned to	assigned to	
Equipment & Consumables	0	130,600	
Travel & Subsistence	15,700	17,000	
Individual grants	74,300	152,400	
Subtotal	90,000	300,000	
RFBR funds	assigned to	assigned to	
Equipment & Consumables	68,300	0	
Travel & Subsistence	6,700	0	
Individual grants	0	0	
Subtotal	75,000		
Total	165,000	300,000	465,000

OTHER RELEVANT INFORMATION

23 If you have any other relevant information on your project, you can enter it here:

The proposal has been reviewed by the international referees of the Physics Research Committee and the Scientific Council at DESY. The referees encouraged our group to submit the proposal for the application of a Helmholtz-Russia Joint Research Group.

FINALLY, WE ASK YOU TO GIVE US THE NAMES AND FULL COORDINATES (INCLUDING EMAIL) OF FIVE SCIENTISTS THAT ARE ABLE TO EVALUATE YOUR PROPOSAL AND ARE IN NO WAY INVOLVED IN THE PROJECT.

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THANK YOU FOR COMPLETING THIS FORM

DEADLINE

The deadline for submitting the proposal (electronically at Helmholtz) is 31st May 2011
Send applications with **6 copies** of all application material plus a CD Rom with a pdf file of the material to the **Head Office of the Helmholtz Association, Ahrstrasse 45, D-53175 Bonn, Germany.**

GENERAL QUESTIONS

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