Helmholtz Alliance – HA-101
Physics at the Terascale

Annual Report 2012

30th May 2013

Project Number	HA-101
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Scientific Manager	Prof. Dr. Christian Zeitnitz
Administrative Coordinator	Dr. Karsten Büßer
Coordinating Helmholtz Centre	DESY
Partners (enumeration)	DESY, KIT (Großforschungsbereich), RWTH Aachen, HU Berlin, U. Bonn, TU Dortmund, TU Dresden, U. Freiburg, U. Gießen, U. Göttingen, U. Hamburg, U. Heidelberg, KIT (Universitätsbereich), U. Mainz, LMU München, U. Rostock, U. Siegen, U. Würzburg, U. Wuppertal, MPI für Physik, München, U. Regensburg
Reporting period	01/01/2012 - 31/12/2012

1 Summary: Project Development

The Helmholtz Alliance "Physics at the Terascale" (www.terascale.de) is a network comprising the Helmholtz Centres DESY and KIT, 18 German universities and the MPI für Physik, München. It is part of the international research programme which investigates the structure of matter with accelerators at the highest energies, the LHC as well as a future linear e^+e^- collider. It develops structures and supports cooperations that go beyond single sites and experiments and connects theory and experiment. It enables a more effective use of existing funding structures in Germany such as the research groups ATLAS and CMS. Its aim is to collect the expertise and strengths of the participating institutes in Germany, in order to strengthen, also in the long term, the international role of German particle physics. The Alliance has four scientific pillars: Physics Analysis, Grid Computing, Detector Development and Accelerator Physics.

In 2012 all the infrastructure of the Alliance has been available and was heavily used by the partner institutions. An especially heavy usage has been recorded for the test beam at DESY, the irradiation facility in Karlsruhe and the Tier-2 computing centres. The latter was due to

the very good performance of the LHC accelerator and the corresponding large data volume to be processed for the data analysis of the experiments.

The sixth annual workshop of the Alliance took place in December 2012 at DESY, Hamburg site with approx. 300 participants. The abundance of results from the LHC experiments and especially the discovery of a new Higgs-like particle, triggered very interesting studies of the working groups and made the workshop particularly interesting.
The school and workshop program attracted in total more than 1000 physicists at all levels, from students to high rank physicists, which shows the high visibility of the Alliance in the German community. Some of the topical workshops attract participants from other countries as well. In general many of the schools have by now become part of the yearly schedule of particle physics events in Germany and are an integral part of the education of young physicists.

The Institute Assembly met during the annual workshop in December 2012. The meeting was dedicated to the financial planning of the Alliance in the years 2013/14, the selection of funded project for these two years. It has been decided to establish a new management of the Alliance in June 2013. The International Advisory Board met as well during the annual workshop and supported the decision of the Institute Assembly to provide funding for three central projects in the years 2013/14. The Board strongly encouraged the management to pursue the continuation of the Alliance structures and infrastructure.

Outreach activities of the Alliance focus on the financial support for the organization of the "Weltmaschine" Exhibition and the International Masterclasses. In 2012 the traveling "Weltmaschine" exhibition has been shown in five different locations all over Germany with over 20,000 visitors. In total the exhibition has been visited by more than 100,000 visitors since 2009.

2 Alliance continuation in 2013/14

In summer 2012 the Alliance has been extended by the Helmholtz Association by two more years, albeit with a reduced funding of 500 k€ per year. The funding will be used in the coming years to finance the Backbone program, e.g. schools, workshops, working group meetings and guest support. This will include funding for speakers and students. In addition it has been decided by the Institute Assembly to fund three projects with a total amount of 750 k€:

- Enabling Technologies for Silicon Microstrip Tracking Detectors at the HL–LHC.
  Involved institutes: Aachen, Berlin, DESY, Freiburg, Hamburg, KIT
- Inclusive and Semi-Inclusive Constraints on the Parton Distributions at the LHC and the Study of Hard Processes.
  Involved institutes: DESY, KIT, Mainz, Freiburg, Wuppertal, Hamburg
- Performance optimization for the present and next generation HEP data analysis on the Grid.
  Involved institutes: DESY, KIT, Aachen, Göttingen, Munich, Wuppertal

The selection process for these projects included an open call for proposals and a reviewing process by the International Advisory Board.

3 Management

The management structure of the Alliance reflects the different activities within the German high energy physics community. Experimental physicists from different experiments and theoretical physicsist are represented from Universities as well as research centres. The project boards are responsible for the research topics of the Alliance, hence provide the management directly with first hand information about the corresponding activities.
The structure http://www.terascale.de/general_information/alliance_structure is very efficient and allows a close contact with all involved research areas and the partner institutions. Through frequent meetings of the Management Board it is possible to react quickly to developments and maintain the contact between the groups.
The International Advisory Board provided in 2012 guidance and support for the management and helped reviewing the project proposals for the years 2013/14.

Members of the Management Board

Chair	Christian Zeitnitz (University Wuppertal)
Members	Thomas Hebbeker (RWTH Aachen), Joachim Mnich (DESY), Markus Schumacher (University Freiburg), Dieter Zeppenfeld (TU Karlsruhe)
Ex-Officio	Ties Behnke (DESY), Karsten Büßer (DESY), Klaus Desch (University Bonn), Lutz Feld (RWTH Aachen), Herbert Dreiner (University Bonn), Eckhard Elsen (DESY), Matthias Kasemann (DESY), Ulrich Uwer (University Heidelberg),
Guest	Thomas Schörner-Sadenius (DESY)

4 Main Scientific Achievements

The operation of the LHC accelerator at CERN in 2012 was outstanding. The data accumulated by the experiments surpassed the expectation substantially. This allowed to announce the discovery of a Higgs–like particle already in July 2012. This discovery was only possible due to the smooth operation of the experiments and the high level of understanding of the detectors. In addition to the discovery of this new particle a large number of very interesting results were published already very shortly after the data had been collected. Alliance members have been involved in the discovery of the Higgs–like particle as well as in numerous analyses by the ATLAS, CMS and LHC-b experiment, hence are knowledgeable in all aspects of the measurements. This is important for the subsequent inclusion of the results into combined analyses within Alliance working groups.
The published results are the basis for the Alliance working groups, which span experiments as well as experiment and theory. Multiple meetings of working groups took place in 2012. Especially active were the $M_{\tau\tau}$ and the central jet veto groups. The former LHC-D working groups, which existed already prior to the Alliance, met in the context of the Annual Alliance workshop.

The LHC accelerator continued its operation until the beginning of 2013 and went into a 2 year shutdown. During this shutdown the experiment will install the first upgrades to the detectors. The preparation time is short and the involved Alliance groups are busy with

corresponding activities.

The first publicised results were important and exciting for the Analysis project of the Alliance. This pillar of the Alliance brings together experimentalists from different experiments and theorists in order to interpret the data, helps to educate the young researchers to gain experience in different techniques (e.g. simulation and data analysis tools, statistics) and organises corresponding workshops and schools. Alliance members contributed to results from LHC as well as the HERA experiments.

The preparation of the physics for a future linear collider (e.g. ILC) is another important topic within the analysis project. The "Linear Collider Forum", which was founded in 2010, had again a very successful workshop in 2012 with more than 100, including substantial international, participants.

The high luminosity operation of the LHC accelerator lead to very high data rates of the LHC experiments, which in turn put substantial pressure on the computing infrastructure of the Worldwide LHC Computing Grid (WLCG). The Alliance co-financed so–called Tier-2 centres in Aachen, Freiburg, Göttingen, Munich and Wuppertal, in cooperation with the Tier-2 at DESY and the MPI Munich, performed extremely well and provided the experiments with the resources for the reconstruction, analysis and simulation of LHC events.

The Tier-1 center for the ATLAS and CMS experiments in Germany is located at the KIT in Karslruhe. Data from CERN are sent to KIT, are processed, and significant simulation is done. The alliance contributes significantly to the Tier-2 ressources of ATLAS and CMS in Germany, which amount to approximately 10% (equivalent to about 8000 CPU-Cores and 10 PB of storage space) of the total Tier-2 resources deployed world-wide. About half of the Tier-2 resources in Germany are provided by centers at universities. In addition, a similar amount of resources for end-user analysis is provided by the National Analysis Facility, NAF, at DESY and by partners at universities. Within the World-Wide LHC Computing Grid, the German centres rank among the most reliable ones.

The preparations for the next big project in particle physics, the linear collider, continued through 2012. The discovery of the Higgs–like particle at the LHC gave an additional boost to this activity. The development of high-gradient superconducting acceleration modules was one of the key areas. DESY is the worldwide leading laboratory in this area. Together with partners from the Alliance, the production of high grandient cavities has been improved substantially. The imminent start of the mass-production of the superconducting rf-cavities for the European XFEL makes quality assurance tools one of the key components. These cavities are pratically identical to the ones required for a future linear collider.

Simultaneously, the development of detectors for this future facility is ongoing. The Alliance is active in a few key technological areas, e.g. time projection chamber and hadron calorimeter. Through the Alliance, the basis of this research in Germany could be significantly broadened and some of the initiated projects have obtained funding from other agencies.

Members of the Alliance are among the leading institutes in preparing a coherent detector concept for a future linear collider. This detector concept, the ILD detector, submitted a letter of intent in 2009. Since then the ILD concept was asked to prepare a full technical design report by the end of 2012. Within the Alliance the linear collider community organised itself in the Linear Collider Forum, where the ongoing work towards this goal, the detector development work, and the physics studies are being discussed. A main focus of the work in the following

year will be to understand the results from the LHC, and to study the impact these results will have on the physics case for the ILC. The Linear Collider Forum, through its working group focussing on the interpretation of LHC data, is very well positioned to make important contributions in this area. Especially the discovery of the Higgs–like particle at the LHC has a substantial impact on the ILC planning.

German theory groups have been active in 2012 in a wide array of particle physics research. An internationally leading role is played in precision calculations for LHC phenomenology, where a number of technically challenging calculations have been presented in the areas of top quark physics, production and decay of weak gauge bosons, and flavor and Higgs boson production and properties. In the light of the measured mass of the newly discovered Higgs–like particle, these results become especially interesting.

These precision calculations are complemented by phenomenological investigations. Examples include the development of new tools and observables for Higgs boson properties, or for tests of supersymmetric models and more general models of electroweak symmetry breaking. Of particular importance for the analysis work within the Terascale Alliance is the development of Monte Carlo tools.

4.1 Milestones

The following table lists the milestones as specified in the proposal for 2012 and their status. For the Analysis as well as the Detector Project all milestones have been already been fulfilled in the previous years.

Date	Work Package	Milestone	Status
Grid Computing			
12/2010	WP1	Optimisation of data access	partially [#1]
Accelerator Physics			
12/2010	WP2	Improvement of beam profile diagnostics using laserwires, electro-optical sampling and beam position monitors	partially [#2]
06/2011		Improvement of electron source emittance	OK [#3]
10/2012		Results from exploratory studies on plasma wakefield accelerators in close collaboration with MPI of Quantum Optics and investigation of experimental options at the University of Hamburg	OK [#4]

[#1] The very high data volume collected by the LHC experiments in 2012 and the corresponding reviews of the data models, lead to changes of the data access and distribution concepts. These will be implemented over the coming years. A final conclusion on this milestone will not be possible.

[#2] The transfer of S. Khan from DESY to Dortmund delayed the work on this topic. Therefore it has been addressed only partially.

[#3] Milestone has been met in 2012

[#4] Has been met already in 2011. The group of Jens Osterhoff established a strong experimental activity at DESY and Hamburg. The transfer of F. Grüner from Munich to the University Hamburg complemented this activity in 2011.

5 Physics Analysis

Members of the Project Board

Chairs	Ulrich Uwer (University Heidelberg), Herbert Dreiner (University Bonn)
Members	Martin Erdmann (RWTH Aachen), Stefan Gieseke (TU Karlsruhe), Michael Kobel (TU Dresden), Klaus Mönig (DESY), Thomas Schörner-Sadenius (DESY), Peter Uwer (HU Berlin), Georg Weiglein (DESY)

The physics analysis activities of the Alliance collected within the Analysis Project and to a large extent organised by the Analysis Centre. Certain topics as well as a number of detailed analysis subjects, bridging theoretical and experiment-specific aspects, are addressed by dedicated working groups (WP1) which try to join the efforts and the experience existing in the different theoretical and experimental partner institutes of the alliance.

The Analysis Centre also covers the work packages WP2 and WP3 - namely educational aspects (via a broad range of schools and training events for physicists at all career levels) and scientific communication (via a series of expert workshops and regular seminars, among other things).

5.1 WP 1: Analysis Network

5.1.1 Analysis Working Groups

There are currently two types of working groups: DESY-centered groups covering broader subjects and trying to form networks across the Alliance, and specialised analysis groups bringing together different experiments, different institutes, and experiment and theory.

Currently, a number of specialised analysis working groups are still active and typically meet 2-3 times a year. These groups are focused efforts of a number of colleagues from different institutes and experiments working on a single, well-defined question and exchanging ideas beyond the usual experiment and institute boundaries.

- Invariant Mass of τ-lepton pairs - $m(\tau, \tau)$
- Neutrino masses and Lepton Flavor Violation (LFV) at the LHC
- Central Jet Veto (CJV)

The groups aim to develop and verify analysis strategies and profit from an intense exchange of analysis concepts and experiences between different experiments and, at the same time, from the dialogue with theorists about theoretical limitations or new theoretical concepts.

The $m(\tau,\tau)$ group was again very active in the further development of techniques to extract the background from data, determine the signal shape by embedding/reweighting methods. These methods are actually utilized in ATLAS as well as CMS.

The central jet veto (CJV) method is a method to optimize the extraction of interesting Standard Model electroweak processes, which are in addition an important background to the corresponding production of Higgs Bosons at the LHC. Results have been presented and discussed during a workshop in Mainz in April 2012 and at the Annual Alliance Workshop at DESY.

The Lepton-Flavor Violation (LFV) working group ist studying the possibility of R-parity violating supersymmetric extensions of the Standard Model. Again experimental and theoretical physicsists are involved.

The working groups start to extend their reach by inviting more and more international guests. In addition physicists, who are not members of the Alliance, start to get interested and join the meetings.

5.1.2 Monte Carlo Group

The Monte Carlo group and the related network (which comprises besides DESY personnel also a YIG in Karlsruhe, a dedicated position in Wuppertal and several contributions from different universities) are connected (via individual authors) to several of the major Monte Carlo event generators used by the community, like CASCADE, HERWIG++, WHIZARD. The former focus on Monte Carlo, tuning with early LHC data, has now shifted to the further development of the generators and to fundamental research, especially in the areas of parton showers and the issues of matching and merging. In addition, members of the group contribute to dedicated studies involving experimental and theoretical expertise.

5.2 WP 2: Analysis Centre at DESY

The Alliance Analysis Centre has shown to be very successful to strengthen the analysis collaboration between the Alliance partners and to improve the scientific communication. Following the example of the Terascale Alliance, laboratories such as CERN and Fermilab have established "LHC Physics Centres". The Alliance Analysis Center reflects this development by strengthening the relation to the new centres and by expanding its international cross links.

5.2.1 The Analysis Centre Groups

Detailed analysis subjects are addressed by the Analysis Working Groups. The working groups aim to join Alliance partners from different institutions, and from theory and experiment. The four working groups with the widest scope are integrated into the Analysis Centre. They address the following topics: Monte Carlo generators, statistic tools, parton distribution functions (PDFs) and SUSY / BSM parameter fitting.

Parton Distribution Functions (PDFs): The Alliance activities in the field of PDFs has received a new boost by funding provided for a new project in the years 2013/2014 and with the installation of two positions in the Analysis Centre (starting April 2013). Furthermore, the HERAFitter project will receive support from the Analysis Centre. In general, Alliance members

have made and continue to make substantial contributions to the field of PDFs, and specifically to the development of the ABM and HERA-PDF PDF sets (many main authors from DESY).

The members of the SUSY / BSM group are very active in the extraction of observables for physics beyond the Standard Model. It is clear that this activity will become more and more important with increasing collected LHC luminosity. Different programs exist in this context: GFitter, SFitter, Mastercode, Fittino, Prospino and HiggsBound. The group aims at common interfaces in order to simplify the usage of the packages and improve the maintainability as well.

The Statistics Tools group provides expertise in a wide range of statistical topics and contacts to many major statistical software packages. In addition, people from the group contribute to numerous statistics packages like TUnfold (main authorship), RooUnfold, TMVA, and others.

The Monte Carlo group of the Analysis Centre is integrated into the corresponding activities at different partner institutions (see Sec. 5.1.2).

Furthermore, the groups organised numerous schools and workshops and are contributing to the overall education of the Alliance members, see Section 5.3.

5.3 WP 3: Training and Exchange

5.3.1 Schools and Workshops

Name	Date	Place	Participants
Introduction to Terascale Physics	5-9 Mar	Hamburg	45
Monte Carlo School	12-16 Mar	Hamburg	44
Statistics School	2-5 Apr	Hamburg	72
Statistics and BSM Physics	20-24 Aug	Bonn	52
Advanced Programming Concepts	8-12 Oct	Hamburg	57
Proton Structure in the LHC era	22-24 Oct	Hamburg	53

Table 1: Schools organised by the Analysis Centre in 2012

Workshop	Date	Place
3rd Linear Collider Forum	7-9 Feb	MPI Munich
Top Quark Workshop	22-23 Mar	Berlin
SM4 and Single-top Workshop	26-28 Mar	Leinweiler
8th $m(\tau,\tau)$ Workshop	2-3 Apr	Freiburg
Central Jet Veto working group meeting	19-20 Apr	Mainz
Event Generators and Resummation	28 May - 1 Jun	Hamburg

Table 2: Expert workshops organised within the framework of the Alliance in 2012

In 2012, the Analysis Centre organised - partly in collaboration with other panels - six schools for students and young post-docs (see Table 1 for details). The participation was in general high

and varied, depending on the topic, between 40 and 70 participants. The topics covered a range from very general introductory courses to very specific software issues. The feedback from the participants was good. It was pointed out that especially the hands-on parts of the schools and the tutorials have been particularly useful for many of the participants. It is envisaged to extend these elements in the future. All schools are evaluated by questionaires. This feedback from earlier schools showed that especially the hands-on parts of the training events were considered to be particularly valuable and helpful. In 2012, therefore, the fraction of such hands-on parts in the school was considerably extended, up to more than 50%. As the new feedback shows, this is the right direction to go, and it will be further pursued in the future.

In addition, other training events were supported by the Analysis Centre or other Alliance bodies like the project boards, for example the DPG school on "Heavy particles at the LHC" or the GridKa school at the KIT.

As in the past years, numerous expert workshops were organised by the Analysis Centre, or massively supported by it organisationally and financially. Table 2 gives an overview of the most prominent examples. All in all, 8 major and some smaller events were organised, and in all cases the productive working atmosphere stimulated intense discussions and new research directions. An excellent example is the"Event generators and resummation" workshop in May 2012, which attracted numerous of the world experts and which will be continued in 2013 and beyond. The 2013 edition will take place in Durham, UK, with massive involvement from Alliance colleagues, and after 2013 the series will go back to Alliance institutes.

In addition to the workshop programme, which will be continued, the Analysis Centre organises regular "Analysis Centre seminars" on topics related to the working groups described above, and it also contributes, with some other institutes, to the "Alliance Computing seminars" which, during the semester, are held on a weekly basis and broadcast to the Alliance community.

5.3.2 Further activities

A number of other and smaller activities are also organised and pursued by the Analysis Project and the Analysis Centre:

- The Analysis Centre organises the so-called "Theorist of the week" - visits of high-level theorists to DESY or other Alliance institutes during which a series of seminars and discussions are scheduled. In 2012 the following colleagues visited DESY, gave a seminar, visited the LHC groups at DESY and were available for informal discussions for one week: Marco Guzzi, John Collins, Nikolaos Kidonakis.

- The Analysis Centre and the Analysis Project Board provide, on request, funding for projects or travel support.

- The Analysis Centre provides funding for guest scientists at DESY and the other Alliance institutes.

6 Grid Computing

MISSING

Members of the Project Board

Chair	Matthias Kasemann (DESY)
Members	Günter Duckeck (LMU München), Volker Gülzow (DESY), Andreas Heiss (KIT), Thomas Kress (RWTH Aachen), Arnulf Quadt (University Göttingen), Günter Quast (TU Karlsruhe)

6.1 Tier-2 Centres in Germany

In 2012 the LHC experiments ATLAS and CMS each collected a luminosity of about $\approx$20 fb^{-1} of proton-proton collisions, an increase of a factor of 4 compared to 2011. These data were promptly distributed, stored and analysed in the Tier-1, Tier-2 and Tier-3 computing centres globally.

The German Tier-2 centres at the universities (Aachen, Freiburg, Göttingen, Munich and Wuppertal) are supported to a large extend by the Alliance. Together with the GRID centres at DESY, KIT and the MPI in Munich they build the German share of the world-wide LHC Computing grid (WLCG). They support LHC data analysis for the German scientists as well as contribute to the data production and analysis of the whole LHC experiments.

The increased LHC data volumes required substantial increases of computing and storage resources at the Tier-2 centres. These increases were provided in time for the successful and timely LHC data analysis. In ATLAS the German Computing Cloud is the 2nd biggest overall and is operating very reliably. For the CMS experiment the Aachen and DESY sites are among the most attractive sites for analysis, due to the reliable operation, the large storage and CPU resources provided and excellent networking connections.

Providing excellent networking connectivity is key to successful distribution and access to large volumes of data. The international LHCOne project aims to provide effective entry points into a network infrastructure that is intended to be private to the LHC Tiers. This infrastructure is addressing the connection needs of the LHC Tier-2 and Tier-3 sites, which have become more important in the emerging less-hierarchical computing models of the experiments. A prototype infrastructure was setup up, connecting German Tier-2 sites through the European Networking project GEANT with other international networking partners globally. Initially the Terascale Alliance institutes Aachen, DESY, KIT together with GSI and University of Frankfurt are connected with a 10/20 Gb infrastructure provided by the Deutsche-Forschungs-Netz (DFN). The LHCOne project is under active development and it is expected to connect all German Tier-2 centres in 2012 when it becomes production quality.

6.2 The National analysis Facility (NAF)

The NAF is located the DESY sites in Hamburg and Zeuthen. It provides resources for all steps of analysis for the LHC as well as for the ILC experiments.

The NAF consists of a large data store, interactive resources for fast turn-around, a fast file system and local batch resources. It is used for data processing, skimming, slimming, to produce ntuples and to plot results as well as for code development. It strengthens the analysis

capabilities of the German groups substantially. The NAF was heavily used for analysis in 2012. It is used by scientists from all German ATLAS, CMS and LHCb LHC sites as well as by the ILC experiment.

Regular coordination meetings of users and the operation team support the smooth operation of the NAF as well as planning for the future. Improvements and upgrades to the file system, further increases to the performance and reliability and extensions to the functionalities for interactive usage are ongoing.

6.3 Grid Development Projects

All German centres use the dCache storage system, which is supported by the Alliance support team.

The "Happy Faces" monitoring product, which is developed with significant support from the Alliance, is in operation at most German Tier-2 centres. It allows real-time site monitoring and it acquires information automatically. Historical information is available for retrieval from a database for performance tuning and correlation studies. It is now also deployed at several non-German CMS Tier-1 sites. The support for the project has been transferred from the KIT to the group in Göttingen.

The specific requirements concerning the software environment within the HEP community constrain the choice of resource providers for the outsourcing of computing infrastructure. The development of virtualization in High Performance Computing clusters and in the context of cloud resources is supported by the Alliance.

New developments are starting in the framework of the Alliance. Especially the utilization of new hardware technologies, like graphic processing units (GPU), are evaluated for the application in the data processing, analysis as well as for the data taking directly at the experiments.

7 Detector Development

Members of the Project Board

Chair	Lutz Feld (RWTH Aachen)
Members	Doris Eckstein (University Hamburg), Alexander Dierlamm (TU Karlsruhe), Ariane Frey (University Göttingen), Hans Krüger (University Bonn), Hans-Christian Schultz-Coulon (University Heidelberg), Felix Sefkow (DESY), Stefan Tapprogge (University Mainz)

7.1 Detector Workshop 2012

The annual detector workshop of the alliance is a unique forum to present detector developments within the alliance and to discuss the challenges of future projects. In 2012 the workshop was held at Bonn University (14. - 16. March). With 76 participants it was again very well attended. This time the focus was put on "New Technologies", "Low Mass System Design", and "Calorimetry". The workshop was accompanied by a school on FPGA programming for which we received more applications than places were available. It will be repeated in the

context of the 2013 edition of the workshop which takes place from 26. 2. to 1. 3. 2013 at Mainz University.

7.2 Detector R&D Projects

In September 2009 six R&D projects were approved for funding during the second half of the original scope of the alliance. These projects therefore came to a conclusion at the end of 2012 and reports have been given at the annual meeting of the alliance in December 2012 .

All six projects have been very successful. Significant progress has been made, which is also apparent in a large number of publications and international visibility of these alliance projects. The concept to provide key infrastructure to the community and to foster collaboration beyond the boundaries of the big terascale experiments has proven to be very valuable.

7.3 Irradiation and Characterization of read-out and detector components

Over the past 2.5 years many alliance groups have performed irradiation studies at the Karlsruhe cyclotron and X-ray source which have been made available in the context of this alliance project. Silicon pixel and strip detectors as well as more exotic sensors like diamond detectors have been irradiated to the fluences expected at the luminosity upgrade of the LHC and several articles including proper Alliance acknowledgement have been published. The project was not limited to Alliance institutions. In 2012 a successful collaboration with the HLL Munich and CERN has been came to a conclusion.

Due to the support of the Alliance to develop infrastructure at the IEKP (KIT) several alliance groups could contribute significantly to the R&D for the upgraded CMS Tracker. One topic, which was covered by a diploma thesis, was the radiation tolerance of various silicon materials.

7.4 A Test Bench for a Fast Data Transmission Line

In this project groups interested in high speed optical communication joined forces to develop a test bench which allows in depth analysis of fast data links.
A suite of boards, firmware, and software have been devised and commissioned. Main focus in 2012 was a test beam study of fast transceiver hardware developed in Heidelberg. An Altera GX FPGA attached to optics being able to operate up to 3.125 Gb/s was used to generate and receive data for comparison. The board was operated in a 22 MeV Proton beam and the FPGA got irradiated up to ≈400 kRad with different dose rates. First analysis of the tests showed a dosage dependent bit error rate. Nevertheless the FPGA survived up to dosages of 200 kRad. A more detailed analysis is still ongoing.

In parallel to this investigation optical components and their behavior have been studied in more detail. While the test optics in the test beam were fast single mode, single channel, SFP packaged devices, in Mannheim and Wuppertal slower multimode transmission lines (160 Mb/s) were used to study the optical behavior with respect to a complete readout chain behavior. This included signal manipulation concerning duty cycle and delay as well as data protocols and parallel operation of up to 12 channels in an array. Bit error rate measurements showed a very stable operation for several TByte of data corresponding to a BER of 10^{-14}.

To reach the goal of a test bench capable of modular testing of high-speed transmission components, the next FPGA chip generation needs to be utilized.

The base work in terms of a transmission board and also in terms of data and signal handling in firmware is done and a first test using a XILINX Kintex 7 evaluation board has been started.

7.5 Development of Novel Powering Concepts for Tracking Detectors

One of the alliance fellowships was awarded for the development of a novel powering concept for future tracking detectors. Within this project such a novel powering scheme was worked out and prototypes were tested in the use case of one of the LHC tracker upgrades.

The CMS and ATLAS experiments foresee upgrades of their tracking detectors in view of the luminosity upgrade of the LHC. The new trackers will feature more readout channels and additional functionality, which leads to increased power demands. Novel powering schemes must be exploited to power these devices, as space and cooling capacity available for supply cables is limited, and since the material budget inside the active tracking volume must be limited as much as reasonably possible. Two options have been widely discussed: Serial Powering and DC-DC conversion. Both allow delivering the required power at a lower current compared to conventional powering. In Serial Powering the current is recycled by powering several detector modules in series, while in DC-DC conversion the power is delivered to the detector at a larger voltage and lower current. In both cases power losses on the supply cables are significantly reduced.

Within the work package a powering scheme based on the DC-DC conversion technique has been worked out for the CMS phase-1 pixel upgrade. With a conversion ratio of 3-4, the power losses on the supply cables are reduced by a factor of about ten. The DC-DC converters are based on the AMISx ASIC family, developed by CERN. DC-DC converters have been developed that fulfill all requirements of the pixel project, in particular the space constraints. These converters have a current capability of 4 A, very low radiated and conducted noise levels, and good thermal management. The efficiency amounts to about 80% and is very uniform. The inductor has been carefully optimized and a highly effective but low-mass shield has been developed. The shield also functions as cooling contact for the coil, a method that has been proven to work very well. System tests have been performed with present CMS pixel modules and up to 24 DC-DC converters on a motherboard. Both the electrical and the thermal performance have been studied. The noise of the pixel modules does not increase due to the powering with DC-DC converters, as compared to conventional powering with the real pixel power supply.

While the studies have been conducted with a specific application – the CMS Phase-1 pixel upgrade - in mind, most of the results are by no means restricted to this application. Results have been presented at many international conferences, and were very well received. DC-DC converters are now also foreseen for the CMS calorimeter upgrade and the BELLE 2 detector, and are considered for the CMS and ATLAS Phase-2 tracker upgrades.

7.6 Ageing and Background Sensitivity of Particle Detectors

The tandem accelerator of the Maier Leibnitz Laboratory at Garching has been made available for ageing and background sensitivity studies with 20 MeV protons and high energetic neutrons (MeV-range). The goal is to test gaseous particle detectors under high rate background rates.

We established two different beam facilities for irradiation studies.
First a proton beam facility has been installed. For that purpose a 20 MeV proton beam has been utilized, which can be used for localized irradiation with beam spot sizes from 1 mm^2 to 1 cm^2. By wobbling the proton beam spot, sizes of 7 cm$\times$1 cm are possible. This experimental setup was applied for ageing studies of drift tube detectors.
Secondly a neutron irradiation facility was established to test gaseous detectors with high energetic neutrons on large areas in high background environment. For that purpose three different neutron creation reactions were investigated.

- The breakup of 20 MeV deuteron on beryllium solid state targets
- 30 MeV α-ions on beryllium solid state targets
- 60 MeV boron-ions on gaseous hydrogen

The characteristics of the created neutrons are determined by a newly developed neutron beam monitoring-system. This monitoring system consists of Pulse Shape Discrimination detectors (PSD)-detectors, which distinguish between neutrons and γ-particles. The neutron flux measurements were measured with γ-insensitive BF3-counters. With the above mentioned neutron creation reactions we can produce high energetic neutrons with energies from 7 MeV to 11 MeV and high background rates from 10^4 Hz/cm^2 to 10^7 Hz/cm^2.
The presented proton irradiation facility was applied for several more experiments, like localized irradiation for track efficiency measurements (published in arXiv:1203.2952) of drift tube detectors and moreover for irradiation of CVD detectors in collaboration with the University of Dortmund.
The neutron irradiation facility was used to test resistive strip micromegas in collaboration with Wotschak (CERN). Both irradiation facilities and the beam monitoring system are available for further experiments.

7.7 Virtual SiPM Laboratory

Participating institutes: Aachen, DESY, Hamburg, Heidelberg, Mainz, MPI, Wuppertal

The Virtual SiPM Laboratory (VSL) has been initiated within the Helmholtz Alliance in 2009 in order to strengthen the existing research efforts on SiPMs (Silicon Photomultipliers) and gain from an intensified collaboration between the participating institutes. The research activities comprise

- CALICE Analog HCAL project (DESY, Hamburg, Heidelberg, Mainz, Munich, Wuppertal)
- SiPM characterization and testing (DESY, Hamburg, Heidelberg, Munich)
- Development of SiPM readout electronics (Heidelberg, Mainz)
- SiPM response modeling and simulation of combined Scintillator/SiPM systems (Aachen, DESY, Hamburg, Heidelberg, Munich)
- Optical calibration of SiPMs (DESY, Hamburg, Wuppertal)
- Medical application of SiPMs (DESY, Hamburg, Heidelberg)

The Helmholtz Alliance financially supports these research activities concerning (a) the ASIC development by funding the submission of several test chips (Heidelberg), (b) the design and construction of a portable SiPM training platform for students and newcomers in this research field (DESY), and (c) the adaptation and further development of available infrastructure (Wuppertal). An extension of the VSL by the University of Aachen is planned; in this context further support to allow for more extensive simulation studies has been applied for.
The status of the supported projects is as follows:

ASIC Development

In the framework of the VSL two ASIC chips are being developed, one, KLauS, for the charge and fast discrimination readout of SiPMs and the other, STiC, for SiPM readout in ToF applications with picosecond time resolution. Since 2010 the work mainly focuses on the development and characterization of the next version of STiC (version 2) which is optimized for use in ToF-PET systems. The new STiC2 ASIC has 16-channels and is available since summer 2012; since then it is being tested. Up to now the chip shows the expected performance. Preliminary results measuring coincident photons from a ^{22}Na source using fast scintillating crystals read out with Hamamatsu MMPCs show a coincidence time resolution of 330 ps. The chip originally designed for the EndoToFPET-US project is also investigated in context of ToF detector for the planned Mu3e experiment. A final version of the chip to be used within the EndoToFPET-US project will be available end of 2013.
Concerning the KLauS ASIC (version 2.0) available since 2010, the chip is now fully characterized showing the expected performance in all relevant aspects. In particular it shows a signal-to-noise ratio of larger than 10 for input charges above 40 fC. At present KLauS3 is being developed which will include an ADC with a pipelined capacitor switching structure. A version of the KLauS chip including the full digital chain necessary for use within the CALICE AHCAL project is planned for 2014/2015. The present version of the chip (KLauS2) is used in a prototype setup for the automized characterization of large numbers of scintillator/SiPM systems as needed for the construction of a high-granular scintillator-based hadron calorimeter with millions of channels.

Data Acquisition development for the ILD analog hadronic calorimeter

Mainz has developed and tested the first prototype of the new Clock & Control card (CCC) for the CALICE Analog HCAL. The card was successfully employed in 2012 test beams. A second component to the readout, the digital read-out board (LDA) will be soon tested during 2013 test beams.

SiPM Portable Test Stand

The responsibility of the SiPM education test box for the characterization of various types of SiPMs has been taken over by the University of Hamburg. By now two fully equiped prototypes exist, one in operation at the University of Hamburg and one in Bonn. Both devices are used for bachelor projects. Other members of the Alliance can request further copies or borrow the existing test stands on request.

Infrastructure

The upgrade of a test stand for the characterization of scintillator tiles with SiPM readout at MPI with a substantially faster DAQ system has been successfully completed. The test stand has also been further extended to be able to accept SiPMs from different manufactures with substantially different gain and pulse shapes. The data analysis framework for the test stand has been completely rewritten based on the software developed for the T3B test beams at CERN, providing the options to run on the Grid for large high-resolution scans and locally for smaller data sets. With the current version of the test stand, the characterization of new scintillator tiles with larger SiPMs developed at ITEP and of tile prototypes for the CALICE AHCAL technological prototype from the University of Hamburg have been performed.

LED calibration system

The development of the CALICE LED calibration system has been continued in Wuppertal. The purpose of the system is the correction of the gain of the SiPM due to temperature and changes of the operation voltage. In 2012 the main focus was on the timing of the LED pulses and the homogeneity of the SiPM response for the readout boards, which can handle 144 scintillating channels. These measurements were performed on the test stand at Wuppertal, where each individual channel has been checked with respect to timing and signal amplitude. The equalization of the very short calibration pulses has been studied under laboratory conditions as well as with electrons in the test beam at DESY. These detailed measurements of gain curves of the SiPMs and the light outputs of the LED system, have shown, that the developed system is suitable for the analog hadronic calorimeter. The reliability of the components is still in issue. The number of non-functional channels (LEDs and/or SiPMs) is still too high and the reasons have to be understood before a mass production for a large-scale detector can be started.

SiPM characterization

DESY and the University of Hamburg have intensified the characterization of novel SiPMs from various producers. In addition to more usual characterization in terms of the key performance parameters new studies have been started on the investigation of radiation hardness of SiPMs. We investigate the effects of X-ray radiation on commercial SiPM photo-detectors. We exposed the sensors to 20 kGy from an X-ray source and compared the current-voltage, capacitance/conductivity-voltage, pulse-height spectra before and after illumination. Interpretation of results is on going.

Digital-SiPM for medical applications

DESY and the University of Hamburg have recently gained experience with the operation of digital SiPM for application in medical imaging. A custom-made prototype chip with 16 test geometries was produced for the EndoTOFPET-US project and fully characterised. This technology is also promising for applications in high-energy physics.

7.8 Bump Bonding for Flip-Chip Development

The aim of this project was to establish a low volume bump bonding facility which can be used in the R&D phase of ASIC and detector development when large scale industrial solutions are less practical. The infrastructure has been set-up and commissioned at Heidelberg University and can now be used by members of the alliance.
The PacTech solder bumper can add individual solder bumps at a pitch of $< 100\mu$m to devices which cannot be ordered with commercial solder bumps. It has been used for prototyping in various projects, two of which are briefly highlighted here:
The Belle-II PXD collaboration develops a large DEPFET pixel detector module, which relies on flip-chip mounting of several steering and readout chips directly onto the thinned detector silicon. Solder balls are mandatory to reduce the mounting pressure on the thin and fragile devices.
The SWITCHER steering chips are manufactured in a high-voltage semiconductor technology for which solder bumps are still not commercially available (at least for the low volume multi-project submission). The in-house bumping is a flexible and cost effective solution compared to a commercial engineering run.
The SWITCHER chips as well as another interface chip have first been populated with gold-stud bumps to provide a solderable surface. The PacTech solder balls have then been placed on top of the flattened gold bumps. In this way the large readout chip and the smaller interface chip have successfully been mounted onto a fan-out adapter.
The goal of the XNAP project (X-ray Nanosecond APD Pixels) is a fast 2D X-ray detector consisting of a segmented avalanche photo detector bump bonded to a fast counting pixel readout ASIC. Solder balls are required because the APDs are very pressure sensitive. The new full-size assemblies consist of an "interposer" PCB to which four APDs and four 5×5 mm^2 ASICs are solder bumped on both sides. Full size dummy chips, used to practice the soldering and cleaning of four chips at once, had to be solder bumped in house. A bigger solder volume was required to successfully mount the chip to the substrate, which was easily provided by the flexible PacTech bumper by stacking 4 balls. The assemblies have recently been operated successfully.

8 Accelerator Physics

Members of the Project Board

Chair	Eckhard Elsen (DESY)
Members	Ralph Aßmann (CERN, now DESY), Wolfgang Hillert (University Bonn), Shaukat Khan (TU Dortmund), Günter Müller (University Wuppertal), Allen Caldwell (MPI-Munich)

Participating Institutes: DESY, Bonn, Dortmund, Hamburg, Wuppertal, MPI-Munich and CERN

The education and training of students has continued to be one of the main aims in of the accelerator project in the Alliance *Physics at the Terascale*. The group continued its successful

exchange of ideas across the specific fields e.g. in presentations at the Annual Meetings. In addition the university lecture series by DESY physicists in Göttingen were continued. The were supplemented by lectures at a Graduate School in Freiburg.

The Terascale Alliance related activities in the various location are described below.

8.1 Bonn

Beam diagnostics

A new beam line allowing for the recording the UV (wavelength 200 nm) part of the emitted synchrotron radiation has been successfully set up. During commissioning, the quality of the imaging of the beam profile could be substantially improved by proper adjusting the collimation system based on moveable slits which absorb unwanted stray-light. Meanwhile, a streak camera has been ordered from funds of the collaborative research centre, which will allow a time-resolved analysis of the longitudinal and transverse beam profile with ps-resolution.

Beam dynamics

The settings of the 3d-bunch by bunch feedback system were further improved. A newly constructed stripline kicker, adopted to the bunch repetition rate at ELSA and based on a coaxial design, has been installed in 2012. Due to the improved bunch to bunch isolation caused by the shorter strips of this device, the feedback characteristics in the transverse planes improved significantly. Work is ongoing to investigate the effects of beam neutralization and to further improve the understanding and damping of ion induced beam instabilities at injection energy.

Test areas

The performance of the existing LINAC I, serving a test area which is dedicated for irradiation of detector electronics and target material, has been improved. Irradiations of detector electronics, which had been started in 2011 were continued in 2012. In order to further reduce the energy spread of the beam, an energy compression system based on a magnetic chicane and a short accelerating structure, will be constructed and installed in 2013.

The installations at the new external 3.5 GeV electron beam line dedicated for detector testing have been continued. The missing steerer and quadrupole magnets, the supports for the magnets and the beam pipe, and the vacuum system have been constructed and installed in the experimental area. Work is ongoing to install the extraction septa and to finish the preparation of the area (civil construction, beam dump, power distribution). First beam in the experimental area is expected within 2013.

8.2 DESY

Superconducting RF cavities

With the imminent start of the mass-production of the superconducting rf-cavities for the European XFEL the high-gradient programme at DESY has been focussed on establishing

the necessary tools for quality assessment of some of these cavities and an additional set of 24 cavities reserved for detailed investigation. The latter cavities are foreseen to operate at gradients above 35 MV/m, well above the requirement for the European XFEL. While the recipe for manufacture is well-established such fields will only be possible with meticulous attention to surface quality. DESY has developed the optical inspection tool OBACHT, which automatically records images of the inner surface of these cavities. These pictures have already served to qualify the mass production series of the cavities.

The automatic processing of these images is subject of a thesis work, which invokes sophisticated pattern recognition algorithms to identify surface features that could reduce the performance of the cavities.

Some surface features lead to excessive heat deposited locally on the surface. Eventually the corresponding temperature increases above the λ-point of the coolant He-II. The propagating phase transition can be recorded with oscillating super leak transducers. A thesis investigating the characteristics of such quenches on a significant cavity sample has been completed in 2012.

Preparation of Plasma-Wakefield Experiments

The engagement of DESY for the preparation of plasma-wakefield experiments proceeds jointly with the University of Hamburg and in collaboration with outside institutes. The programme is described further below.

The DESY engagement in plasma wakefield experiments has significantly increased with the attraction of B. Foster in 2011 and R. Aßmann in 2012. Experiments in Hamburg are planned at the REGAE and FLASH facilities which provide beams at ≈10 MeV and 1 GeV respectively for injection into a plasma cell. The former experiment is led by F. Grüner of Hamburg University, who complements the activities of the YIG mentioned below. The planning of the FLASH beam line is involved since it proceeds next to a new user facility FLASH II. DESY has attracted a Helmholtz Postdoc Fellowship which at least in part will be devoted to this task. These activities are complemented by a Helmholtz Virtual Institute of B. Foster bound to start in the course of the year 2013.

8.3 Dortmund

TU Dortmund joined the accelerator project when Prof. S Khan, originally Hamburg, became the chair of accelerator physics in Dortmund albeit with no Terascale Alliance funds assigned.

8.4 Hamburg

The Helmholtz Young Investigator Group for Plasma Wakefield Acceleration (PWFA) of J. Osterhoff, founded in 2010, completed recruitment in early 2012. The group attracted eminent physicists who applied for a second Helmholtz Postdoc Fellowships, which will be granted in July 2013.

The group also applied for computing time at the JUQUEEN HPC in Julich, which will provide the necessary compute power for 3d-simulations that ultimately are the basis of planning the proposed experiments at DESY and elsewhere.

Simulations of Plasma-Wakefield Experiments

A key requirement for the successful application of PWFA to realistic beams is the control of emittance during acceleration. A first study addressing cascading of several plasma acceleration stages has been published. This study will be continued in collaboration with James Cook University in Townsville, Australia.

A quasi-static Particle-in-cell (PIC) code, HiPACE, has been developed jointly with LBNL, CA, USA. This numerical code reduces resource requirements by an order of magnitude for some problems of PWFA.

Self-modulation experiments foreseen for the PITZ-facility at DESY-Zeuthen have been simulated in detail to understand the specific parameters that may lead to the observation of the effect.

Plasma wake fields exhibit a very strong longitudinally accelerating component. At the same time the focussing transverse fields slightly off-axis are very large. The net compression of 1 fs-bunches injected into a realistic plasma has been simulated and led to promising results, which now have to be verified experimentally.

Experiments

A Capillary Discharge Waveguide (CDW) has been developed and tested at the Lund Laser Centre in August 2012. The cell demonstrated laser guiding in the expected fashion; electrons were accelerated to 400 MeV in 15 mm cells. The experiments were carried out in collaboration with Oxford University and LMU Munich.

The technique of Raman scattering has been extended to densities of 10^{-17} cm^{-3} hitherto regarded as very challenging for density diagnostics.

The plasma formation in such a cell can be ignited by an external laser pulse - a process which is being studied. It is seen as a promising technique for supporting the experiments.

These experiments also require the diagnostics of the beam post-acceleration. First successful experiments have been carried out at the ASTRA Gemini Facility am Rutherford Appleton Lab in Oxfordshire, UK. These experiments are analyzed in close collaboration with Imperial College London.

8.5 Wuppertal

Research in high gradient superconducting rf cavities

During the first half of 2012, the correlated FESM and SEM measurements of parasitic field emitters on the large-crystal and single-crystal samples prepared at DESY and JLab were completed and supported by the Helmholtz Alliance.

Surface irregularities have been identified as main emitter type on the four BCP-polished and HPR-cleaned single-crystal niobium samples from JLab. Their activated onset field depends on the removed damage layer and shifts from 80 MV/m for 20 µm to 180 MV/m for 120 µm as expected from the remaining average surface roughness. The power spectral density (PSD) and a 2D discrete Fourier transform analysis of the measured optical profiles have been considered for a fast surface quality control.

The SEM images of emitters on the four high purity (RRR > 300) large-crystal and single-crystal niobium samples prepared at DESY (BCP 40 µm + HPR) and in-situ heated (24 h at 122 °C, 2 h at 400 °C and 2 h at 800 °C) at BUW were completed. These results are most interesting for the ILC and will soon be published. Like the actual large-grain cavities at DESY, these samples were electropolished (140 µm) and HPR-cleaned at DESY. A second series of in-situ heating cycles with more steps at temperatures below 400 °C and successive FESM measurements has been started to reveal the emitter activation mechanism.

Optimisation of electron and positron sources

By means of a running BMBF project, in 2012, the UHV-based system for photo-induced field emission spectroscopy (PFES) has been completed with a tunable pulsed laser (0.5 – 5.9 eV, ≈1 mJ in 3.5 ns, 10 Hz). Systematic measurements on flat Au and Ag cathodes gave evidence for some resonances but only low quantum efficiency in the photo emission regime. Moreover, the achievable electric field was limited to about 20 MV/m by parasitic field emission. Therefore, improved sample cleaning techniques and laminar air-flow conditions were planned and will be installed soon.

8.6 CERN and Max-Planck-Institute Munich

These activities are new and not funded by the Terascale Alliance. They are mentioned here since they continue to initiate considerable networking for exchange of ideas.

Proton driven plasma wakefield acceleration

Under the leadership of the Max-Planck Institute Munich a Letter of Intent (LoI) to carry out a proton-driven plasma wakefield experiment using the SPS beam of CERN was submitted and successfully reviewed by the SPSC. The AWAKE Collaboration was formed, and is currently writing a Conceptual Design Report to perform a first-ever plasma wakefield experiment with a proton driver. The experiment will probe the self-excitation of the wakefields in a long plasma cell and the acceleration of a bunch of electrons in the wake of the proton bunch.
The experimental program is planned to start in 2015.
Such experiments use a long proton bunch and thus complement the experiments planned at DESY. There is a lively exchange of experimental and theoretical ideas between the approaches.

9 Backbone Activities

9.1 Interim Professorships

The substitute for the scientific manager at the University of Wuppertal continues to be funded via this scheme.

9.2 International Networking

The visits of Dr. Marco Guzzi (Southern Methodist University), Prof. John Collins (Penn State University) and Prof. Nikolaos Kidonakis (Kennesaw State University). as the “Theorist of the

Week", were financed by the Alliance through the Analysis Centre.
Travel cost for internationally renowned speakers at workshops and the annual meeting has been provided by the Alliance.

9.3 Equal Opportunities

The dual career support was successfully used for the fellows in Hamburg, Freiburg, Karlsruhe.

9.4 Outreach

The very successful exhibition "Weltmaschine" was transformed in 2009 into a travelling exhibition. In 2012 the Alliance provided again financial support for the organisation (G. Hörentrup).

Many Alliance partners participated in the particle physics Master Classes that are organised world-wide each year. The Alliance is supporting the organisation of the international Master Classes, which is located at the TU Dresden (U. Bilow).

There are also many activities involving Alliance members and schools, ranging from lectures and physics days to visits to schools (e.g. "rent a scientist").

10 Personnel

Personnel funded by the Helmholtz grant:

	Male	Female
PhD students	22	2
Scientists	37	11
Technical personnel	6	1

Other personnel involved in the Helmholtz Alliance projects in 2012:

	Male	Female
Diplom/Master students	127	27
PhD students	168	42
Post-docs	165	45
Senior scientists	94	15
Technical personnel	49	4

11 Publications

The complete list of Alliance-related publications is attached to this report. In total there were 530 papers published in refereed journals, 745 conference contributions and proceedings, preprints and other publications.

12 Dissertations

31 (9 female) PhD theses on Alliance-related topics were completed in 2012.

13 New Cooperations and Activities

Most of the new cooperations and activities within the Alliance are detailed in the sections on Physics Analysis, Grid Computing, Detector Development and Accelerator Physics.

Alliance funding was important in the successful involvement in the Advanced European Infrastructures for Detectors at Accelerators (AIDA) project. The project is co-funded by the European Commission within Framework Programme 7. AIDA (http://cern.ch/aida) addresses the upgrade, improvement and integration of key research infrastructures in Europe, developing advanced detector technologies for future particle accelerators, as well as transnational access to facilities that provide these research infrastructures.

14 Teaching

As mentioned above, the Alliance organised schools on Terascale physics, Monte Carlo, Statistics and software techniques. The high attendance and success of the schools shows that the Alliance clearly fills a need within the whole particle physics community. These activities will be continued in 2013.