Helmholtz Alliance

"Physics at the Terascale"

Annual Report 2007

Project Number	HA-101
Scientific Coordinator(s)	Prof. Dr. Rolf-Dieter Heuer, Prof. Dr. Peter Mättig
Coordinating Helmholtz Centre	DESY
Partners (enumeration)	DESY, FZ Karlsruhe, RWTH Aachen, HU Berlin, U Bonn, U Dortmund, TU Dresden, U Freiburg, U Gießen, U Göttingen, U Hamburg, U Heidelberg, U Karlsruhe, U Mainz, LMU München, U Rostock, U Siegen, U Würzburg, U Wuppertal, MPI für Physik, München
Reporting period	01/07/2007 - 31/12/2007

Summary: Project development

- The Alliance started its work immediately following the official start on 1 July 2007. A first meeting of the institute assembly, the governing body of the Alliance, was held on 2 July 2007 in Berlin, where the statutes governing the Alliance were discussed and adopted. The main bodies (the four Project Boards and the Management Board) were elected and started their work.
- The Alliance had its first general meeting in December 2007. 345 people, many of them young physicists (Diplom and PhD students as well as post-docs), attended the workshop. This workshop set the scene for "Physics at the Terascale". Exceptionally, the physics was discussed by a series of external speakers, while the chairs of the Project Boards as well as the management presented summaries of progress and their plans for the coming years. During the workshop the International Advisory Board had its first meeting. It elected Dieter Schlatter, CERN, as its chair. The minutes of meeting are attached to this report.
- After the initial meeting in July, the Institute Assembly also met during the kick-off workshop and discussed the progress of the Alliance infrastructure, finances and personnel. Each partner has two members in the Institute Assembly, in almost all cases an experimental and a theoretical physicist.
- The Alliance received a high degree of coverage in the press and high-energy physics community during 2007. Articles about the Alliance in the "Physik Journal" (Germany), "Physics Today" (USA) and the "CERN Courier" reported on the Alliance, its goals and the new structures it started. A longer in depth CERN courier article is scheduled for spring 2008.
- The list of partners of the Alliance has not changed, though discussions started almost immediately after the start with potential new partners.
- The main management positions – scientific coordinators, scientific manager, and administrative coordinator, were all filled by October 2007. The scientific manager, Prof. Dr. Ian Brock, took up his post on 1 October 2007 and is on leave of absence from the University of Bonn until February 2010.
- Very soon after the start the Alliance advertised a number of new positions. Of particular interest are the Young Investigator Groups (YIGs), of which five of the planned six groups were advertised in 2007, as well as the first round of Alliance

fellowships for young researchers. For the YIG leaders the selection committees included members of the Alliance from partner institutes.

- The selection of the fellows followed a completely new procedure. The member institutes who were interested in hosting a fellow applied to the Alliance for a position. In a competitive process the available positions were distributed among the requests, and were then centrally advertised. Applications were collected centrally by the Alliance, and two Alliance-wide selection boards evaluated the applications and decided who should receive an offer. The same committees advised both the Universities of Wuppertal and Siegen on their choice for tenure-track positions initially financed by the Alliance.
- At the end of 2007, Prof R.D. Heuer, one of the scientific coordinators of the Alliance, was selected as the next Director General of CERN, starting as of 1 January 2009. As a consequence Prof. Heuer stepped down as scientific coordinator early in 2008, and was replaced by Dr. Ties Behnke, DESY.

Main scientific achievements

The main focus of the activities of the Alliance during 2007 was the organisation of structures, the start of work for new infrastructures, and the search for people who will work within the Alliance. Therefore, there are only few scientific results which can be reported from the Alliance at this stage, although a lot of progress has been made on preparing the ground for the work planned over the next few years and the Tevatron continues to collect and analyse data with steadily increasing luminosity.

The ATLAS and CMS Collaborations have been concentrating on installing and commissioning their detectors. There has also been a substantial amount of work on evaluating the physics potential for initial lower luminosity expected during the start-up of the LHC. The whole software chain from the detector to producing physics results has been further developed and tested. Almost all groups within the Alliance are members of the ATLAS and CMS collaborations and have been heavily involved in setting up the detector, the software and the physics analysis. The activities of the Alliance partners resulted in numerous publications in refereed journals as well as in conference proceedings and experiment-specific notes.

At the Tevatron, almost 4 fb^{-1} of proton-antiproton collision data at a centre-of-mass energy of 1.96 TeV has been collected. Data analyses have been performed involving groups of the Alliance (Aachen, Bonn, Freiburg, Göttingen, Karlsruhe, Mainz, München, Wuppertal) . The Tevatron experiments CDF and D0 continue to provide a very good training ground for hadron collider physics at the upcoming LHC. The main emphasis of these studies were in the area of top quark physics and searches for the Higgs boson, supersymmetry and other phenomena beyond the Standard Model, all of which are part of the goals of the Alliance

Highlights include:

- measurements of the top-antitop quark production cross-section;
- further consolidation of measurements of single top quark producton;
- properties of the top quark, including the determination of its mass to 172.6 ± 1.4 GeV/c^2;
- very large improvements in the sensitivity to a Higgs boson, allowing one to become almost sensitive to the Standard Model expectation;
- improved sensitivity to other phenomena beyond the Standard Model.

In 2007 German theory groups have continued to play an internationally leading role in precision calculations for LHC phenomenology, and have contributed a number of technically challenging new calculations specifically in the areas of Higgs production in vector boson fusion, top quark physics and electroweak gauge boson production. Collider signatures of new physics scenarios, in particular supersymmetry, have been analysed, and the reconstruction of fundamental parameters at the unification scale combining LHC and ILC

data has been studied. Of particular importance for the analysis work within the Terascale Alliance is the development of Monte Carlo tools, where German groups in 2007 have made major contributions to the multi-purpose Monte Carlo generator Herwig and have launched a new tool for Beyond the Standard Model LHC event simulation.

In the research topic of Grid computing one of the main activities of the groups involved to come to a stable operation and also to develop the Grid to a more user-friendly environment.

Research and Development has been intensified on new detectors for the sLHC focussing in particular to the areas of silicon detectors and muon chambers. New concepts and ideas are particularly followed in sensor designs, electronic interconnects and light materials.

Novel detector technologies which are applicable to a future linear electron-positron collider are being developed by many Alliance partners in the fields of vertex detectors (DEPFET), gaseous tracking (LCTPC) and highly-granular calorimetry (CALICE).

Key issues in the development of the ILC accelerator connected to the production of high-gradient RF cavities and damping ring design are worked on at DESY, Hamburg, Bonn and Wuppertal.

The following table gives the list of milestones as specified for completion by the end of 2007 as well as their status.

Milestones

Analysis

07/2007	WP1	Call for the YIGs and first round of fellow appointments	OK
10/2007		Constitution of the Virtual Theory Institute	OK
12/2007		Fill majority of 07/2007 positions	06/2008
12/2007		Call for theory fellowships to be filled in 10/2008	11/2007
10/2007	WP2	Analysis centre at DESY ready for access	OK
09/2007	WP3	First version of collaborative tools ready (Web +Wiki pages) available	Web OK, Wiki in progress
10/2007		Start of VTI seminar programme	04/2008

Grid

10/2007	WP1	Tier-2 centres operational with first batch of resources	02/2008
10/2007		NAF operational with first batch of resources	04/2008
12/2007		Grid-based mass storage system data service set up	OK
10/2007	WP3	Start of Grid training activities	05/2008

Detector

2007		No milestones	

Accelerator

04/2007	WP1	First lectures on accelerator science at external universities	OK

The activities of the four Project Boards are detailed in the following sections.

Analysis

The goal of the Alliance analysis work package is to support the German groups investigating the Terascale, and increase cooperation on topics such as LHC analysis and physics studies for the ILC. A particular focus here is on establishing and supporting a set of Alliance working groups, many of which are on experiment independent topics, a novel concept at least for the LHC experimental groups.

Further Important components of the data analysis structure in the Alliance are the Young Investigator Groups (YIGs) and the analysis centre at DESY. They are complemented by

fellowships in experimental and theoretical physics. In addition collaboration between German institutes will be fostered by the creation of a Virtual Theory Institute (VTI).

The Young Investigator Groups give young researchers a chance to start a small research group by receiving funding for his/her own position and a small number of post-doc and PhD positions. The YIG is hosted by a specific university, which – as a condition for funding of this group through the Alliance – had to guarantee a tenure-track position for the leader of the YIG after the end of the Alliance funding. Five YIGs were advertised in 2007, three in theoretical physics (Berlin, Göttingen , Karlsruhe) and two in experimental physics (Dresden, Wuppertal). The YIG in Karlsruhe is targeted towards Monte Carlo generators, which is of special interest for the whole of the alliance. It has already been filled; for three others the final list of candidates exists; the YIG in Wuppertal is in the selection phase.

Nine theory and eight experimental fellowships have been advertised. These positions run over a period of at least four years. About one third of the positions is fully financed by the alliance, the rest is co-financed by the alliance and the host institute. The positions have been advertised centrally as alliance fellowships allowing the applicants to select the institute they would like to work at. A large fraction of the positions has been filled. In addition, two tenure-track positions have been opened, one for phenomenology in Siegen and one for Monte Carlo in Wuppertal for which also an offer has been made (a short-list for the Siegen position exists, interviews will take place early in 2008). More than 200 applications were received for the various positions from all over the world. Of the 15 fellowships filled so far, six were offered to women, of whom five accepted the position.

The analysis centre at DESY started its work with about ten members selected from the DESY staff. It is temporarily lead by the experimental chair of the analysis project board. The Monte Carlo group has already made a detailed workplan and is organising a school that will take place at DESY in April 2008. The groups dealing with statistics and parton distribution functions have made a preliminary planning for schools later in 2008. The position of the leader of the analysis centre has been advertised and the selection process is currently in progress. This position will be a tenure-track position secured by DESY. The topics for the other positions in the analysis centre financed by the Alliance are under discussion.

A central tool of working together scientifically within the Alliance are the Alliance working groups. A number of larger groups have been established in 2007, most of them based on preparatory work within the German high-energy physics community under the auspices of KET (Komitee für Elementarteilchenphysik) which started before the approval of the Alliance. They are focused on physics to be done at the LHC. The workshops cover a wide range of physics topics, including supersymmetry and Higgs physics. Smaller groups on specific topics (e.g. structure functions, tools, etc.) are being formed. The community is encouraged to form more such groups whenever needed. Apart from giving such groups a formal basis and a structure, the Alliance supports their work through travel funds.

To foster an improved communication and collaboration among the various German theory groups, a Virtual Theory Institute (VTI) is currently being established. The VTI will organise small workshops on specific theory topics, support the collaboration among theorist with travel funds and set up a new virtual theory seminar that is broadcast through video conference facilities. The organisation of the institute was set up by October 2007 and Prof. Herbi Dreiner (Bonn) is the speaker. The first virtual theory seminar is scheduled to start in April 2008.

Grid Computing

The main goal of the grid work package is the provision of computing resources to the Alliance members. In addition several projects have been defined, which should improve the quality of service and the user interface. A key element of the strategy is the build up of a distributed Tier2 structure in Germany, and the setup of a National Analysis Facility, hosted by DESY.

The main achievements foreseen for the first half year of the computing activities within the Alliance consisted of the procurement and initial installation of the computing hardware in the

Tier-2 centres at DESY and the universities in Aachen, Freiburg, Munich and Wuppertal. The hardware was delivered and the installation is well under way at all centres. Only slight delays were encountered relative to the original plan, due to problems in procuring the needed hardware, but all installations were finished early in 2008.

The Grid Project board organised an initial workshop at DESY during the Alliance kick-off workshop in December, concentrating primarily on the role of the National Analysis Facility at DESY. Prior to this meeting, papers describing the requirements of the experiments ATLAS and CMS had been submitted, and the requested services and their suggested realisation by the DESY IT group were the main topic of the workshop. Other presentations aimed at establishing a connection with projects on interactive analysis in grid environments being pursued within the German e-science initiative D-Grid, in particular the projects related to the HEP community grid. While the hardware installation was progressing according to plans and initial proposals on the technical realisation of the necessary services of the NAF appeared to be relatively clear, it became obvious during the workshop that close collaboration with the users is mandatory for planning the sharing of resources needed for the different services. The creation of a NAF user group with members from the experiments and the DESY IT group was decided. The selection of the members (preferably at the post-doc level) is ongoing. Once the group is established, a dedicated workshop will be arranged to further plan the details of the evolution of the NAF.

Most of the employment of personnel had been foreseen to start in 2008, but some positions could already be filled in 2007, in particular on grid storage (dCache) and virtualisation. Qualified candidates for positions on grid storage, monitoring of grid jobs and services, and for the planning and installation of NAF services at DESY are available for 2008 and the positions will be filled. In February 2008 another workshop in Karlsruhe will concentrate on all work packages within the grid computing project and review status and plans.

One of the main ingredients of the Virtual IT centre within the Alliance is the wide area networking. A group of experts from DESY and the Grid centre in Karlsruhe (GridKa) in close collaboration with the DFN is presently exploring the possibilities for the creation of a dedicated network connecting all partner institutes. A first proposal will be discussed at the workshop on grid computing projects in February 2008.

Detector Development

The Alliance plans to install and operate an ambitious detector-development infrastructure with its partners in Germany. To this end the “Virtual Laboratory for Detector Technologies” has been set up, which will manage the infrastructures.

After the formation of the Detector Project Board, which took place immediately after the start of the Alliance, the goals and the roles of the different planned infrastructures were discussed and investigated in detail. First discussions with potential users took place during the Alliance kick-off meeting in December. A detector development workshop of the Alliance will take place in April 2008 with the goal of intensifying the collaboration between Alliance members working on related R&D projects and of advertising the opportunities the VLDT offers to the community.

Interest in the community on the new structures and possibilities is substantial. A number of novel projects have been proposed, which will only be possible if the central Alliance infrastructures become available. These projects emphasise the cross-detector nature of the Alliance, and stress common developments between groups which otherwise are engaged in a scientific competition. In this way the Alliance is helping to build up new cooperative structures within Germany, and will make the overall contribution to the main HEP experiments more efficient and more visible.

Work at the three central nodes (Bonn, DESY and Heidelberg) and the smaller nodes (Hamburg, Karlsruhe, Aachen) has started, and first improved installations are becoming available. In particular, preparations of laboratory space and rooms for hosting members from partner institutes are already ongoing.

The build-up of the infrastructures is not going as quickly as anticipated n the proposal. In particular investment money is flowing more slowly than planned, partly because some proposed investments are still being discussed, and partly because some investment should only be made once the responsible people within the Alliance have been hired. Some of the funding will therefore need to be delayed into 2008 or 2009.

In addition to the infrastructures the Alliance supports on a small scale a number of specific detector development projects, which are of general interest to the community. Work on these projects has started by recruiting personnel at a number of locations.

The test-beam infrastructure at DESY has been extensively used, especially for ILC studies by the universities in Hamburg, Heidelberg and Rostock, DESY Hamburg and Zeuthen. In addition, studies for the ALFA project within ATLAS were made by Gießen, Würzburg and DESY. An X-ray radiation facility for 10 keV photons with dose rates between 0.5 and 150 kGy/s is being set up at HASYLAB and first studies of surface radiation damage have been made.

The studies of the microscopic and macroscopic properties of radiation-damaged materials (Hamburg) have led to the identification of the microscopic levels that are responsible for the long-term annealing of the effective doping concentration through radiation damage (“reverse annealing”).

In Bonn the already existing infrastructure (SiLab) has mainly been used for Alliance projects in which both Bonn and Alliance partners were already involved: R&D on the upgrade of the ATLAS pixel detector for sLHC (serial module powering scheme, sensor tests, ...), prototype construction of a TPC with pixel readout and preparations for the installation of test-beam infrastructure at ELSA (start of construction of a beam telescope) and studies for a beam dump in the test-beam area.

In 2007 a number of positions could be filled. DESY strengthened its support manpower by hiring two engineers dedicated to the Alliance, who started in January 2008. Manpower in Bonn and Heidelberg is also starting to arrive; the head of the Alliance laboratory in Bonn took up his post on 1 January 2008. Physicist positions engaged in different projects have been filled in Gießen, Rostock and Siegen; candidates have been selected in Dresden and Dortmund.

Accelerator

A key element of the accelerator work package within the Alliance is a Young Investigator Group, located at the University of Hamburg. This group will be started only in 2008. For 2007 activities were concentrated on providing support for partners who want to improve the teaching of accelerator science at universities, and on the search for appropriate candidates for the leader of the YIG. Early in 2008 the first accelerator school organised by the Alliance will take place at DESY.

Two topics are being pursued at the University of Bonn: single bunch generation and accumulation in ELSA, and polarimetry and beam diagnostics of Compton backscattered photons. At the University of Wuppertal studies of enhanced field emission from large-grain niobium with a new microscope and of photo-enhanced field emission are ongoing. DESY and the University of Hamburg are working on the preparation of the high-gradient work for superconducting RF-structures; beam instrumentation for FLASH, which is a continuation of studies on positron source operation; and damping ring optimization for the ILC.

Promotion of early career researchers

A total of approximately 200 PhD students are working on Alliance topics; 16 of these completed their dissertations in 2007. There are also over 170 post-docs within the Alliance, of which 2 completed their Habilitations in the last year. As mentioned above, the head of one YIG group has been appointed. The others will follow in 2008.

The kick-off workshop was an excellent opportunity for all the members of the Alliance to meet and discuss. These activities will be intensified in the more specialised workshops and schools that are planned for 2008.

The technical infrastructure and support as well as the availability of cheap accommodation on site make DESY the natural location for many of the Alliance workshops and schools. However, some of the meetings will also be organised at partner institutes. For example in 2008, the first detector development workshop will take place in Karlsruhe and the annual Alliance workshop will be held in Aachen.

Teaching activities initiated by the Alliance

A full lecture series with exercises on accelerator physics has been offered at the University of Göttingen in the summer term 2007. The Terascale Accelerator School (scheduled for March 2008) has been prepared among the partners.

Further schools planned are: Monte Carlo school (April 2008), Statistical Methods school (September 2008), Parton Distribution Function (PDF) school (November 2008).

Development of the Interim Professorships programme

Both the scientific manager and the ATLAS Physics Coordinator profit from the interim professorship programme.

International networking

In 2007 no guest scientists were funded through the Alliance. However, visits for 2008 were prepared. First visits are expected for 2008.

Equal opportunities initiative

The equal opportunity program by the Alliance proved to be a important programme to recruit key Alliance personnel in at least two cases so far. The possibility to help the partner of an Alliance person to find and get funding for a position in addition to the Alliance job has been used successfully by the Universities of Bonn and Würzburg to recruit top people from overseas to Germany. Several other partners have expressed an interest, so that the proposed funding line might need to be increased to honour all requests. The first positions funded by the program will start in 2008.

Outreach

The LHC Communicator position jointly funded by the Alliance and the BMBF was advertised and an excellent candidate was found who will start on 1 April 2008. In addition the Alliance will support the modernisation and adaptation of the very successful Master classes that are offered to secondary school students each year (coordinated up to now by Prof. Dr. Michael Kobel, Dresden).

With the start-up of the LHC in 2008, outreach activities will play an important role in the coming years.

The Alliance web pages were set up soon after the start so that all members of the Alliance could be informed about its activities. Information about open positions, schools and workshops, as well as the statutes and other important documents is collected there. The activities of the research topics are also documented. The minutes of all the Alliance Boards are published in an internal area, with access restricted to Alliance members. Emails with important information are also sent to the two Institute Assembly members, who are then responsible for distributing the information to their Alliance members within their institute.

Grants and awards

Prof. Dr. Rolf-Dieter Heuer was elected as the CERN Director General as of 1 January 2009.

Publications

Given the size of the Alliance and the large number of participating physicists, only a summary of the numbers of publications is given here. Over 200 articles have appeared in refereed journals; there have been over 40 other publications, e.g. preprints, ATLAS and CMS collaborations technical and physics notes. In addition there were over 120 conference presentations on Alliance related topics.

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Minutes

Helmholtz Alliance: Physics at the Terascale
First meeting of International Advisory Board
4 Dec 2007

Present Jim Brau, Brian Foster, Peter Jenni, Dieter Schlatter, Bernhard Spaan, James Stirling, Tejinder Virdee
Excused: Kors Bos, Sakue Yamada

After short discussion, Dieter Schlatter accepted to serve as chairperson of the board. James Stirling accepted to serve as deputy.

Round table discussion on first impressions:

Overall very positive on goals and potential of Alliance. German community can be congratulated for this opportunity.
Terascale Alliance should become important framework to strengthen the coherence of the high energy physics groups in Germany and deepen the collaboration between theorists and experimentalists.
The continued strong use of the two Helmholtz centres, DESY and FZK, will be to the benefit of the German HEP community.
We are pleased by the large participation of young scientists at the kick-off meeting.
We are impressed by the rapid start-up and the well advanced organization.

Some of us feel that there is an unfortunate exclusion of flavour physics groups. There is increased theoretical interest in probing the Terascale with LHC flavour physics and it would be a pity if the German groups would be weakened by the exclusion from the Alliance.

Theory:

- Young investigator positions, in particular with tenure track, could slow down the present trend of young German theorists to settle in the UK because of lack of adequate positions at home. Move in the right direction.
- What is behind Virtual Institutes? Theorists are organized through many international networks. The Virtual Institutes of the Alliance, if to be understood as networks, should be well connected to these international networks.
- In connection with the Analysis Centre at DESY and the wish for close links of theorists and experimentalists, it would be advantageous if the DESY Theory group has a few phenomenologists working on LHC and/or Linear Collider Physics.

Analysis Centre at DESY:

- could help to create an identity of the German HEP groups, as is present in communities in other countries (US, UK, Italy,…) ,
- must be attractive to the groups (otherwise, why would people go to DESY rather than to CERN?). DESY should be proactive to provide good working conditions for members of Alliance (office space, seminar rooms, network, grid access and software/analysis tools support, etc).
- Centre could be host to existing Workshops/study groups, such as for LHC-ILC or HERA-LHC.

Working Groups:

- Good way to increase cooperation among University groups. Place for brainstorming, training and sharing expertise, but should not become an extra managerial layer in the big collaborations.
- Should liaise with corresponding international WGs

Detector R&D

- Continued strong support for first class detector R&D for ILC at DESY and the Universities and increasingly also for SLHC through the Alliance is very good.
- Build-up of common infrastructure right way to go.
- To combine and upgrade the micro electronics system development centres in Germany is very important. Due to the very high costs of chip development, close contact to the European network on micro-electronic R&D, coordinated by CERN is mandatory.

Grid computing

- Hope that impact of Alliance on Grid computing will help the end-user (Physicist) in the institutes for LHC physics analysis.

Accelerator Physics

- opportunity for DESY and GSI centered accelerator groups to collaborate more.
- School is good idea.
- Why has CLIC been omitted as a topic of the school?

Questions:

1. Theory support for experimental groups. Is the successor of P. Zerwas a phenomenologist?
2. Could the Alliance (or DESY) pick up a responsibility/commitment in the LHC collaborations?
3. Is the Alliance still open to a new WP proposal, e.g. in detector development or analysis?
4. When is the first report from IAB needed?