Annual report

1 January - 31 December 2012

Left to right: Prof Vishnu Jejjala (WITS), Shannon Pincus (Herzlia High School, Cape Town) and Dr Kevin Goldstein (WITS). Shannon was one of two prize winners at the 2012 ESKOM Expo for Young Scientists. Her project was entitled, 'The Gyroscopic Effect of Bicycle Wheels.'

Contents

Abbreviations

AIMS	African Institute for Mathematical Sciences
CPUT	Cape Peninsula University of Technology
CSIR	Council for Scientific and Industrial Research
HartRAO	Hartebeesthoek Radio Astronomy Observatory
ICTP	International Centre for Theoretical Physics
iThemba LABS	iThemba Laboratory for Accelerator Based Sciences
NLC	National Laser Centre
NRF	National Research Foundation
NWU	North-West University
RFP	Request for Proposal
RU	Rhodes University
SAAO	South African Astronomical Observatory
SAASTA	South African Agency for Science and Technology Advancement
SAIP	South African Institute of Physics
SARChI	South African Research Chairs Initiative
SKA	Square Kilometre Array
STIAS	Stellenbosch Institute for Advanced Study
SU	Stellenbosch University
UCT	University of Cape Town
UJ	University of Johannesburg
UKZN	University of KwaZulu-Natal
UL	University of Limpopo
UNISA	University of South Africa
UNIVEN	University of Venda
UNIZULU	University of Zululand
UP	University of Pretoria
UWC	University of the Western Cape
WITS	University of the Witwatersrand
WITS	University of the Witwatersrand

Director's Report

THE YEAR 2012 WAS THE FIRST IN A NEW FUNDING CYCLE FOR NITHEP following its inclusion in the basket of Centres of Excellence. This brought about greater income stability for NITheP which, in turn, made longer-term planning around the future positioning of NITheP considerably easier. However, NITheP is still awaiting a formal response from the Department of Science and Technology and the National Research Foundation on the 2011 review of NITheP and its recommendations. This casts some uncertainty on NITheP's longer-term structure and placement, especially in light of the recommendations of the recent ministerial review of the science and innovation landscape.

As part of NITheP's ongoing policy to engage with the theoretical physics community in a transparent and inclusive manner, the third associate workshop was held in September 2012, during which strategies and longer-term planning around NITheP were discussed extensively.

The first bursary holder workshop was held in 2012. In addition to serving as a platform for bursary holders to engage with management on NITheP's mandate and the role they play in it, the workshop was mainly a scientific meeting. It was open to all NITheP staff and associates, and all MSc and PhD bursary holders gave presentations on their research projects. All attendees were impressed by the high quality of the presentations.

The Request for Proposal (RFP) system under which associates can apply for support for international workshops, visitors and mobility continued in 2012. In total, eight workshops that involved a significant number of local students and researchers were supported under this programme during the year. In addition, long-term visits totalling 11.5 visitor months were supported.

As part of NITheP's policy to engage with and build capacity at institutions that traditionally had no teaching or research programmes in theoretical physics, the first junior associates were appointed in 2012 at the universities of Limpopo and Venda. This almost immediately resulted in greater participation from these institutes in NITheP programmes. There are plans to extend the junior associate programme to other universities in the near future.

The first staff changeover in NITheP took place in 2012, with two researchers finding permanent positions nationally and internationally. This demonstrates NITheP's capability to launch the research careers of, especially, young researchers and effectively contribute to the national pool of human capital.

In terms of research, there was an unexpected increase in outputs for the fourth successive year. This is remarkable considering the staff changeovers and decline in resources. A closer inspection reveals that the growth in research outputs was due to increased contributions from the NITheP network of associates and visitors. This suggests that the NITheP model of a national institute, comprising a national network of researchers and a core team of research staff, is working and strengthening.

With NITheP's longer-terms plans taking shape and new staff joining, we look forward to a very productive 2013.

Frederik Scholtz

Introduction

NITHEP IS A GEOGRAPHICALLY DISTRIBUTED INSTITUTE with regional centres at the Stellenbosch Institute for Advanced Studies (STIAS), the University of the Witwatersrand (WITS) and the University of KwaZulu-Natal (UKZN). Stellenbosch University (SU) acts as the host institution, and the regional centre at STIAS is its headquarters.

The governance system is that of a national Centre of Excellence, which is subject to the notarisation of a binding contract between the granter, the National Research Foundation, and the grantee, namely SU, as the host institution of the NITheP headquarters.

NITheP operates in an independent environment (STIAS), with SU providing administrative support. This is critical in the South African (and African) context to ensure non-alliance with a particular institution and to develop an independent identity. A consortium agreement between the hosts of the three regional centres, namely SU, WITS and UKZN, governs the interaction between the regional centres.

Mandate and Strategy

Vision

NITHEP'S VISION is to be Africa's leading and an internationally competitive research and training institute in theoretical physics, a discipline that provides the conceptual framework for the natural sciences.

Mission

NITHEP AIMS to sustain a stimulating theoretical physics research and user facility that links South Africa internationally through excellence in research and training, thereby supporting scientific innovation, transformation and socio economic development in South Africa.

Strategic goals

TO IDENTIFY and pursue high-level research projects and expand existing expertise in the fields covered by theoretical physics in South Africa;

TO ACT as a national and African user facility for theoretical physics which optimises communication and collaboration between the existing centres of expertise and stimulates joint initiatives in line with international developments;

TO PROMOTE equitable participation from all communities in South Africa in theoretical physics programmes and to strengthen ties with similar communities on the rest of the African continent;

TO PROVIDE a source of expertise which can feed into broad national scientific policies and goals.

The November/December 2012 internship students who did their projects under the supervision of Prof Azwinndini Muronga (UJ and Soweto Science Director) listened to a talk by Prof John Ellis (Clerk Maxwell Professor of Theoretical Physics at King's College, London) about the Higgs boson when he visited the UJ Physics Department. They also visited the Soweto Science Centre.

Governance and Structure

Governance

THE GOVERNANCE STRUCTURE, as set out in the governance document for a national Centre of Excellence, makes provision for the establishment of a board of directors, scientific advisory committee and management committee. The composition of these three core governance committees was as follows on 31 December 2012:

Board members:

- Prof Eugene Cloete (deputy vice-chancellor: research, SU)
- Prof Robert de Mello Koch (School of Physics, WITS)
- Prof Roy Maartens (SKA chair at UWC, Department of Physics; affiliated to Portsmouth University, UK)
- Prof Azwinndini Muronga (director: UJ Science Centre, Soweto Campus; Department of Physics, Faculty of Science, UJ)
- Prof Francesco Petruccione (deputy director of NITheP; SARChI chair Quantum Information Processing and Communication, UKZN)
- Prof João A. P. Rodrigues (deputy director of NITheP; School of Physics, WITS)
- Prof Frederik G. Scholtz (director of NITheP)
- Dr Nthabiseng Taole (programme director: Centres of Excellence, Knowledge Fields Development, NRF)
- Prof Patricia Whitelock (SAAO; National Astrophysics and Space Science Programme)
- Department of Science and Technology representative

Scientific advisory committee:

- Prof Sylvester James Gates (University of Maryland, USA)
- Prof Jan Govaerts (Catholic University Louvain, Belgium)
- Prof Sir Peter Knight (Imperial College, London, UK; president of the Institute of Physics; Kavli Royal Society International Centre)
- Prof Neil Turok (Perimeter Institute, Canada)

Management committee:

- Dr Kevin Goldstein (School of Physics, WITS)
- Prof Francesco Petruccione (deputy director of NITheP; SARChI chair Quantum Information Processing and Communication, UKZN)
- Prof João A. P. Rodrigues (deputy director of NITheP; School of Physics, WITS)
- Prof Frederik G. Scholtz (director of NITheP; chair of the management committee)

Staff

THE STAFF PROFILE of NITheP as on 31 December 2012 is shown in Table 1.

Table 1: Staff profile on 31 December 2012

Position	Node	Number
Director	SU	1 (five-year contract)
Deputy director	WITS/UKZN	2 (five-year contract)
Chief researcher	SU	1 (five-year contract)
Senior researcher	WITS	1 (five-year contract)
Researcher	SU/UKZN	2 (one five-year and one three-year contract)
Research associate	SU	1 (three-year appointment)
Senior administrative officer	SU/WITS	3 (one full-time, one 3/8 and one 5/8 positions, all five-year contracts)
Secretary	UKZN	1 (five-year contract)
Researcher (vacant)	SU	2
Total		**13**

Postdoctoral fellows

THE POSTDOCTORAL FELLOWS per node as on 31 December 2012 are shown in Table 2. All positions comprise two-year contracts.

Table 2: Postdoctoral fellows on 31 December 2012

Node	NITheP funded	Externally funded
SU	2	1
UKZN	2	0
WITS	1	0
Total	**5**	**1**

Service rendering

Marketing

AS NITHEP FUNCTIONS AS A USER FACILITY, it is important to maintain a high level of visibility within the community. Marketing has been emphasised since NITheP's inception and 2012 was no exception.

As usual, an exhibition was held at the annual conference of the SAIP in July. NITheP also participated as an exhibitor during National Science Week at the UJ Science Centre, Soweto campus, on 28 July.

NITheP's policy of active engagement with all tertiary institutions was continued with visits to Walter Sisulu and Fort Hare universities.

Networking

Associate programme

To achieve NITheP's strategic goals, it is crucial to develop a national network throughout South Africa. In 2012, NITheP's very successful associate programme continued growing. The current status of the network, which now consists of two junior, 53 individual, four institutional and three strategic associates, is shown in Table 3. Associates have access to the NITheP visitor, mobility and workshop programmes through a Request for Proposal (RFP) system.

Table 3: Associates on 31 December 2012

JUNIOR ASSOCIATES	
Dr Eric Maluta	UNIVEN
Dr Thuto Mosuang	UL
INDIVIDUAL ASSOCIATES	
Prof Jacek Banasiak	UKZN
Prof Igor Barashenkov	UCT
Dr Bruce Bartlett	SU
Prof Bruce A. Bassett	AIMS, SAAO and UCT
Prof Nigel Bishop	RU
Prof Moritz Braun	UNISA
Prof Erwin Brüning	UKZN
Prof Nithaya Chetty	UP
Dr Chris Clarkson	UCT
Prof Jean Cleymans	UCT
Prof Sergio Colafrancesco	WITS
Prof Robert de Mello Koch	WITS
Prof Cesareo A. Dominguez	UCT
Dr Rocco Duvenhage	UP
Prof Hans Eggers	SU
Prof George Ellis	UCT
Prof Arthur Every	WITS
Dr Kevin Goldstein	WITS
Prof W. Dieter Heiss	SU
Prof Manfred Hellberg	UKZN
Dr William Horowitz	UCT
Prof Vishnu Jejjala	WITS
Prof Daniel Joubert	WITS

INDIVIDUAL ASSOCIATES	
Prof Steven Karataglidis	UJ
Prof Thomas Konrad	UKZN
Dr Mantile Lekala	UNISA
Prof Roy Maartens	UWC
Prof Richard Mace	UKZN
Prof Sunil Maharaj	UKZN
Prof Daniel Makinde	CPUT
Prof Kavilan Moodley	UKZN
Prof Harm Moraal	NWU
Prof Kristian Müller-Nedebock	SU
Prof Azwinndini Muronga	UJ
Dr Jeff Murugan	UCT
Dr Giuseppe Pellicane	UKZN
Prof André Peshier	UCT
Prof Martin Porrmann	UKZN
Prof Marius Potgieter	NWU
Prof Alex Quandt	WITS
Prof Sergei Rakitianski	UP
Dr Stef Roux	CSIR
Prof Pavlo Selyshchev	UP
Dr Alessandro Sergi	UKZN
Dr Izak Snyman	WITS
Dr Gary Tupper	UCT
Dr Herman Uys	NLC, CSIR
Prof Raoul Viollier	UCT
Prof André Weideman	SU
Prof Herbert Weigel	SU
Prof Heribert Weigert	UCT
Dr Amanda Weltman	UCT
Dr Caroline Zunckel	UKZN
INSTITUTIONAL ASSOCIATES	
UCT-CERN (previously known as the Alice Group)	UCT
Centre for Theoretical Physics	UCT
Cosmology Group	UCT
Centre for Space Research	NWU
STRATEGIC ASSOCIATES	
Prof Barry Green	AIMS
Prof Ludwig Combrinck	HartRAO
Dr Zeblon Vilakazi	iThemba LABS

Associate workshop

The annual NITheP associate workshop was held at the NITheP offices in Stellenbosch on 13 and 14 September. The workshop started with a meeting on general associate matters. The second day consisted of a scientific programme, with four 45-minute talks:

- *Solid State Eintopf* by Alexander Quandt.
- *The Color Glass Condensate: QCD at Modern Collider Facilities* by Heribert Weigert.
- *Shedding Light on Dark Energy* by Caroline Zunckel.
- *Black Hole Microstates* by Vishnu Jejjala.

African development programme

Capacity development in theoretical physics in Africa is very much part of the NITheP mandate and agenda. This involvement continued in 2012 with NITheP sponsoring the African School of Physics that was held in Ghana from 15 July to 4 August. This school was also attended by several South African students.

Request for proposal (RFP) system

NITheP gives associates and staff access to NITheP resources and, in particular, the mobility, long-term visitor, workshop and research programmes through a competitive, proposal-driven system. Table 4 summarises the support given to staff and associates under this system during the year. The individual activities listed below are reported on in detail under the appropriate headings (note: not all the proposals approved for support actually materialised and this is due to a variety of reasons).

Table 4: Proposals supported under the RFP system in 2012

Type of activity	Number of proposals
Long-term visitors	7 (11.5 visitor months)
Mobility	1
Schools	2
Workshops	8
Total	18

Mobility

Under the mobility programme, support is provided for associates to travel between South African higher educational institutions and, in particular, to the three nodal centres situated at SU, WITS and UKZN. Support is given for a period of up to two months per year and includes accommodation, subsistence and, in cases that are strongly motivated and justified, transport costs. One proposal was supported under this programme in 2012.

Visitors

A vibrant visitor programme is vital for NITheP's success. Visitors are attracted to NITheP by means of two mechanisms. The first is the long-term visitor programme, accessed through the RFP system. Under this programme, staff and associates can apply for support for longer-term visiting collaborators, typically for a period of one to six months. This support covers accommodation, subsistence and, only in exceptional cases, travel costs.

NITheP also budgets annually for short-term visitors who typically spend a few weeks (less than a month) at a NITheP centre or tertiary institution of an associate. Foreign researchers may apply for support under both of these programmes.

The NITheP short-term visitor programme supported 56 visitors during the year, and the details are indicated in Table 5.

Table 5: Short-term visitors who visited NITheP in 2012

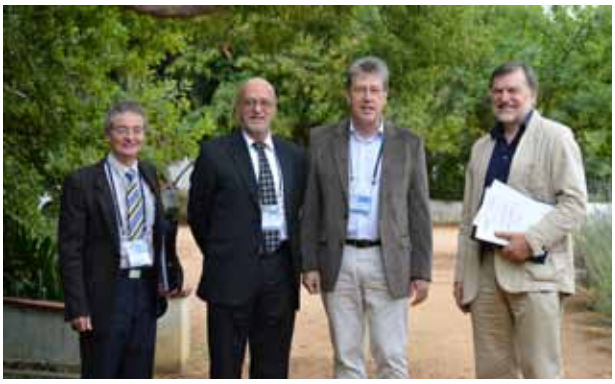
NITheP node	Short-term visitors
SU	14
UKZN	21
WITS	21
Total	56

Table 6 summarises the long-term visitors who were supported under the RFP system.

Table 6: Long-term visitors supported under the RFP system in 2012

Visitor	Home institution/affiliation	Host (institution)	Term
Prof Neven Bilic	Ruđer Bošković Institute, Croatia	Dr Gary Tupper, UCT	1 month
Prof Bengt Fornberg	University of Colorado, USA	Prof André Weideman, SU	1.5 months
Dr Tanja Hinderer	Cahill Center for Astronomy and Astrophysics, California Institute for Technology, USA	Dr Jeandrew Brink, NITheP Stellenbosch	2 months
Prof Jens Koch	Assistant professor, Department of Physics and Astronomy, Northwestern University, USA	Prof Francesco Petruccione	1 month
Dr Hugo Touchette	School of Mathematical Sciences, Queen Mary, University of London, UK	Prof Michael Kastner, NITheP Stellenbosch	2 months
Prof Raju Venugopalan	Senior scientist, Brookhaven National Laboratory (BNL), USA; Adjunct professor, Stony Brook University, New York; Group leader, Nuclear Theory Group, BNL	Dr Will Horowitz, UCT	1 month
Prof Aaron Zimmerman	Theoretical AstroPhysics Including Relativity and Cosmology, California Institute of Technology, USA	Dr Jeandrew Brink, NITheP Stellenbosch	3 months

International workshop on Nuclear Spectroscopy: Frontiers at Magnetic Spectrometers



Prof John Carter (WITS); Minister Derek Hanekom; Prof Peter von Neumann-Cosel of the Technical University of Darmstadt (workshop chairman); and Prof Hendrik Geyer, director of STIAS.

Prof Peter von Neumann-Cosel; Dr Zeblon Vilakazi, director of iThemba LABS; and Roland Herrmann, German Consul General for South Africa.

Students from the SU Faculty of Science conducted popular physics demonstrations during an outreach road trip to the Overberg in September 2012.

Bursaries

A total of 39 bursaries were awarded in 2012. The total actual amount paid out was R2 255 000. The bursaries awarded are summarised in Table 7.

Table 7: Bursaries awarded in 2012

Level	Number	Amount allocated per bursary (R)	Actual cost (R)	Budgeted cost (R)
Honours	8	40 000	320 000	400 000
MSc	15	55 000	735 000	990 000
PhD	16	75 000	1 200 000	1 500 000
Total	**39**		**R2 255 000**	**R2 890 000**

The bursary holders per institution and degree are reflected in Table 8.

Table 8: Bursary holders per institution in 2012

Institution	Honours	MSc	PhD	Total
SU	2	2	3	7
UCT	1	2	5	8
UKZN	1	7	3	11
UNIVEN	1	0	0	1
UP	1	2	2	5
WITS	1	2	3	6
ZULULAND	1	0	0	1
Total	**8**	**15**	**16**	**39**

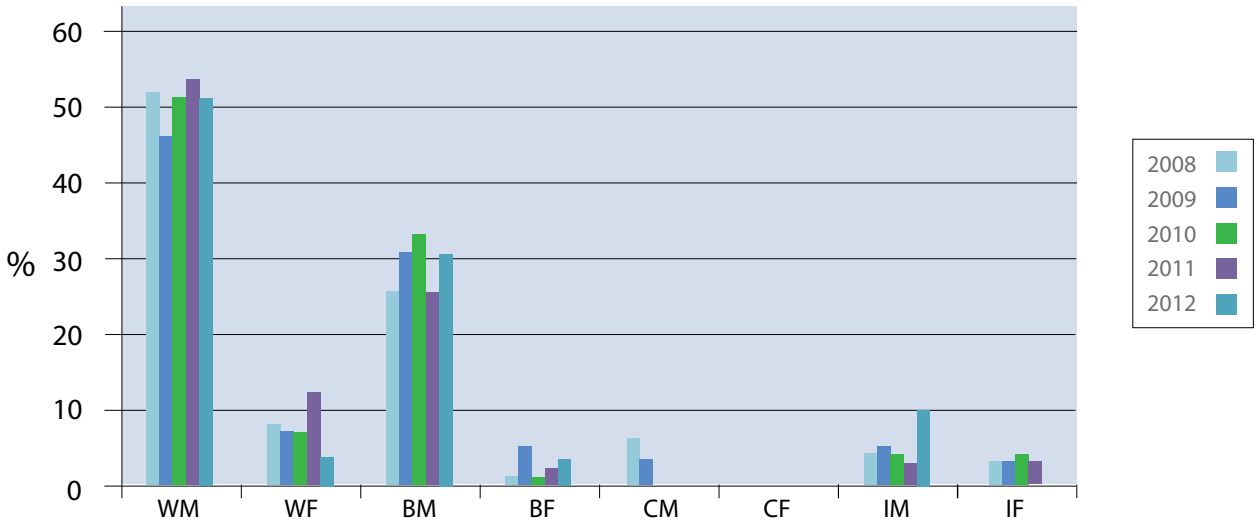
Table 9 shows the details by race and gender. The bursary profile still does not reflect a satisfactory demographic profile, particularly in terms of gender. However, it must be kept in mind that theoretical physics is a non-traditional line of study for many underrepresented groupings and it will take some time to reach a more satisfactory demographic profile. This is also reflected by the much more balanced profile on honours level, where 62.5% of the bursary holders are black and Indian. On this level, bursaries are given purely on merit to students studying general physics rather than specifically theoretical physics, as is the case on the masters and doctoral levels.

Table 9: Bursary holders by race and gender in 2012

Degree	White		Black		Coloured		Indian		Total
	Male	Female	Male	Female	Male	Female	Male	Female	
Honours	3	0	4	0	0	0	1	0	8
MSc	9	0	4	1	0	0	1	0	15
PhD	8	2	4	0	0	0	2	0	16
Total	**20**	**2**	**12**	**1**	**0**	**0**	**4**	**0**	**39**

The change in demographic profile from 2008 to 2012 is reflected in Figure 1.

Figure 1: Demographic profile of bursary holders in the period 2008 to 2012



The first NITheP bursary holder workshop, an open event, was held at the NITheP offices in Stellenbosch on 22 and 23 November. A total of 23 MSc and PhD students presented 20-minute talks. The students enjoyed the challenge of presenting their work to their peers, as well as the opportunity to network with each other and to discuss the various topics covered in their work. This event will take place annually in future.

Internships

The internship programme was continued in 2012. Applications were invited during the first half of 2012.

This programme has two components. The first enables students at Honours or MSc level to join NITheP workshops and complete a small research project, typically on the scale of an honours project, under the supervision of an invited workshop participant. The second component makes provision for students, mainly at honours level or who have recently started at masters level, to join NITheP staff or associates during recess periods to complete a research project.

In both instances, the supervisor and an independent local examiner, usually from the student's home institution, evaluate the project. Students may use the marks generated in this way for credits at their home institution, if the home institution approves of this.

In this way, NITheP provides a training opportunity, often under the guidance of a leading researcher, which alleviates the pressure of project supervision on departments. Typically NITheP supports the students who pass the screening process for this programme in terms of travel, accommodation and subsistence costs.

Table 10 summarises the details regarding this programme during 2012. Particularly encouraging is the considerable number of interns who continue with a higher degree in theoretical physics.

Table 10: Internship statistics for 2012

Student's home institution (host institution)	Number of students	Number of students earning credits	Students who continued with higher degree
AIMS (NITheP UKZN)	2	0	0
NWU (UJ)	1	1	1
SU (UJ)	1	1	1
UCT (UCT)	1	0	0
UCT (UJ)	1	0	1
UJ (UJ)	1	1	1
UNIVEN (UJ)	6	2	6
UNIZULU (UJ)	1	1	1
UWC (UWC)	1	1	1
UWC (WITS)	1	1	1
Total	**16**	**8**	**13**

Travel grants

In addition to the bursary and internship programmes, NITheP also offers support to students, enabling them to travel to national and international conferences and schools. Support is only provided if the student gives a presentation or poster or, in the case of schools, if the supervisor strongly motivates attendance. Support is limited to R5 000 for national conferences and R15 000 for international conferences. Table 11 indicates the statistics for travel grants allocated in 2012.

Table 11: Travel grants allocated in 2012

Institution	National	International
UCT	0	R 15 000
UKZN	0	R 15 000
UP	0	R 15 000
Total	**0**	**R 45 000**

Outreach, community service and the popularisation of science

Public talks

NITheP's outreach includes the popularisation of science. In this regard, NITheP hosts and supports a programme of public talks in the theoretical physics community. These are normally aimed at the general public, students and high school learners in Stellenbosch and surrounding areas. iThemba LABS is usually involved in our events by providing transport to schools that have this need.

NITheP supported the following public talks in 2012:

- NITheP associate and board member Prof Azwinndini Muronga gave a public talk on 12 April entitled *The Atomic Nucleus: A Window to the Early Universe*. This was a UJ Faculty of Science event.
- NITheP associate and board member Prof Roy Maartens gave a public talk on 1 August entitled *Nobel Physics – The Accelerating Universe*. This was an iThemba LABS event.

ESKOM Expo for Young Scientists

NITheP sponsored a mathematics and physics prize at the national ESKOM Expo for Young Scientists for the third consecutive year. NITheP staff and associates also acted as judges at the event, which was held in Johannesburg on 4 October.

The NITheP R1 000 physics category winners for 2012 were:

- *The Gyroscopic Effect of Bicycle Wheels* by Shannon Pincus, Herzlia High School, Cape Town
- *Which are the Best Surfaces for a Swim Start?* by Anrich Kleynhans, Crawford College, Pretoria.

Boyden Science Adventure Camp

NITheP sponsored a speaker at the annual Science Adventure Camp in 2010 and 2011, hosted by Prof Matie Hoffman. A collaboration between the University of the Free State and the Boyden Science Centre, this camp is aimed at top achievers in grade 12 in the Free State area. The camp did not take place during 2012, but will be hosted again in 2013.

Stellenbosch student outreach: physics demonstration for SAASTA

Dr Jabu Nukeri, SAASTA's managing director, visited NITheP during December. During the visit, students from the SU Department of Physics and the Laser Research Institute outreach group demonstrated some of the experiments they normally present on their outreach trips. Dr Nukeri and NITheP thereafter agreed to jointly produce in 2013 a pamphlet on career opportunities in physics for graduates.

iThemba LABS 'Celebrating our She-roes' event

NITheP supported this iThemba LABS event, held on 28 September. The event was a 'for-the-ladies-by-the-ladies' research day for female students from second year to honours level. Dr Adriana Marais from the NITheP UKZN node gave a talk on quantum biology, and the programme included plenary talks, speed dating and a tour of the facilities. NITheP acknowledged and thanked Dr Gillian Arendse of iThemba LABS for the invitation to be part of this event.

Outreach road trip to Overberg

In collaboration with the SU Faculty of Science, NITheP supported several students from the Laser Research Institute, Institute for Theoretical Physics and the greater part of the departments' student body on an outreach road trip. The aim of the trip, which took place during September, was to visit schools in underprivileged communities in the Overberg area. Popular physics demonstrations were given and learners were informed about physics as a career path. Students explained the basic philosophies of mathematical modelling of physical systems and experimental physics. The feedback received was overwhelmingly positive, as was also the case with the West Coast trip in 2011.

Research and training

Research focus

NITHEP HAS A CLEAR research focus, derived from existing research capacity at the nodal centres and strategic priorities. With the appointment of associates, the research focus includes research capacity outside these centres. The current core research activities are centred along the themes:

- Statistical and Condensed Matter Physics (SU, WITS)
- Quantum Information and Computation (UKZN)
- High Energy Physics:
  - String Theory and Matrix Models (WITS, UCT)
  - Phenomenology (WITS, UCT)

A temporary three-year appointment of a researcher in the field of gravitational waves was made, starting on 1 November 2010. The appointment aimed to establish closer links with the astronomical and SKA communities. The appointment was timeous, as there is growing awareness nationally of the development of gravitational wave astronomy. Indeed, during 2012 the Department of Science and Technology sponsored a workshop on this topic, while the NITheP-sponsored Chris Engelbrecht Summer School on Gravitational Waves will follow in January 2013 in Grahamstown.

Schools, workshops and short research programmes under RFP system

NITheP supports workshops and research programmes organised at its nodal centres or an associate's home institution. Programmes are accessed through the RFP system. Workshops typically span three to five days and research programmes a period of one to three months. These activities are often combined.

NITheP's flagship training programme, the Chris Engelbrecht Summer School series, runs annually. This proposal-driven programme enables any member of the theoretical physics or broader physics community to propose a topic, speakers and organising committee for the school.

In 2012 the following schools, workshops and short research programmes were supported under the RFP system.

Schools

The 23rd Chris Engelbrecht Summer School, titled *Quantum Biology,* took place from 18 to 28 January at Salt Rock Hotel, Dolphin Coast, Durban. The organising committee comprised Adriana Marias (NITheP UKZN and PhD bursary holder), Prof Francesco Petruccione (NITheP UKZN), Prof Frederik Scholtz (NITheP SU) and Ilya Sinayskiy (NITheP UKZN). The invited speakers were Andreas Buchleitner (University of Freiburg), Irene Burghardt (Frankfurt University), Artur Ekert (University of Oxford and National University of Singapore), Rienk van Grondelle (University of Amsterdam), Thorsten Ritz (University of California), Raymond Sparrow (CSIR), Birgitta Whaley (University of California), Tjaart Kruger (University of Amsterdam) and Vyacheslay Shatokhin (University of Freiburg). A total of 44 participants, including the speakers, attended the school. More information can be found at www.nithep.ac.za/3ji.htm

Workshops

1. *Cape Town International Cosmology Summer School,* arranged by Prof Bruce Bassett, was held from 15 to 28 January at STIAS. The organising committee was Bruce Bassett (chairman) (AIMS/SAAO/UCT), Paulo Creminelli and Ravi Sheth (ICTP) and Carolina Odman (AIMS). There were eight invited speakers and 72 participants.

2. International workshop *Exploring QCD Frontiers*: *from RHIC and LHC to EIC,* arranged by Prof Heribert Weigert and Dr William Horowitz (UCT), was held at STIAS from 30 January to 3 February. The organisers were Andrew Hamilton, William Horowitz, André Peshier and Heribert Weigert (all from UCT) and Zeblon Vilakazi (iThemba LABS). There were 34 ordinary participants and 14 students. More information can be found at http://nithep.ac.za/3p3.htm

3. International workshop *The African School on Electronic Structure Methods and Applications (ASESMA 2012),* arranged by Prof Nithaya Chetty (UP), was held at the Chepkoilel University College, Eldoret, Kenya, from 28 May to 8 June. The organising committee was George Amolo and Nicholas Makau (Chepkoilel University College, Eldoret, Kenya), Nithaya Chetty (UP), Richard Martin (University of Illinois, USA) and Sandro Scandolo (ICTP). There were 13 lecturers, six mentors, five tutors, two invited speakers and 36 participants. More information can be found at http://bit.ly/VZv7Nh

4. International workshop *Quantum Africa 2* was arranged by Prof Francesco Petruccione (NITheP Deputy Director, UKZN) and held at Mont Aux Sources Hotel, northern Drakensburg from 3 to 7 September. The organising committee was Prof F. Petruccione (chairman) (NITheP UKZN and UKZN), Prof E. Bruning, Prof Thomas Konrad and Dr A. Sergi (all from UKZN), Dr I. Sinayskiy (NITheP UKZN), Dr H. Uys and Dr S. Roux (CSIR) and Dr S. Nic Chormaic (University College Cork and UKZN). There were five invited keynote speakers, ten invited speakers, 35 students and 25 ordinary participants. More information can be found at http://quantum.ukzn.ac.za/events/quantum-africa-2.

5. NITheP research workshop *Dissipative Quantum Computing and State Engineering,* organised by Dr Ilya Sinayskiy and Prof Francesco Petruccione, was held at UKZN from 25 to 28 September 2012. There were six speakers and 30 participants. More information can be found at http://nithep.ac.za/3xu.htm.

6. International workshop *Nuclear Spectroscopy: Frontiers at Magnetic Spectrometers* was arranged by Prof Dieter Heiss and held at STIAS from 19 to 21 November. The organising committee was J. Carter (WITS), P. von Neumann-Cossel (TU Darmstadt), P. Papka (SU) and F. D. Smit and N. Haasbroek (iThemba LABS). The workshop was held under the auspices of the German-South African Year of Science 2012/2013 and the German Consul General in South Africa addressed the participants. There were 45 participants, of which ten were students. For more information, visit www.tlabs.ac.za/spectrometer/default.htm

7. A workshop on *Quantum Information using NV Centres in Diamond,* arranged by Prof Francesco Petruccione (NITheP UKZN and UKZN), was held at Bonamanzi Lodge in northern KwaZulu-Natal from 3 to 7 December. The organising committee was Prof F. Petruccione (chairman), Prof Fedor Jelezko and Prof Martin Plenio (Ulm University) and Prof Alex Retzker (Hebrew University of Jerusalem). There were 17 invited speakers, 22 ordinary participants and 12 students.

8. *Kruger 2012: 2nd workshop on Discovery Physics at the LHC,* arranged by Prof Jean Cleymans, was held in the Kruger National Park from 2 to 7 December. The organising committee was Oana Boeriu, Alan Cornell and Trevor Vickey (all from WITS), Jean Cleymans, W. A. Horowitz and André Peshier (all from UCT), Simon H. Connell (UJ) and Zeblon Vilakazi (iThemba LABS). There were 98 participants, of which 32 were students. More information can be found at www.kruger2012.tlabs.ac.za/kruger2012/index.html and http://nithep.ac.za/3sh.htm

The participation of local and African students in these training events is summarised in Table 12.

Table 12: Student participation in NITheP-organised training events in 2012

Event	South African student participants	African student participants
SCHOOLS		
23rd Chris Engelbrecht Summer School: Quantum Biology	22	3
WORKSHOPS		
Cape Town International Cosmology Summer School 2012	12	17
Exploring QCD Frontiers from RHIC and LHC to EIC	9	5
The African School of Electronic Structure Methods and Applications (ASESMA 2012)	5	31
Quantum Africa 2	19	11
Dissipative Quantum Computing and State Engineering	14	6
Nuclear Spectroscopy: Frontiers at Magnetic Spectrometers	6	2
Quantum Information using NV Centres in Diamond	6	1
Kruger 2012: 2nd workshop on Discovery Physics at the LHC	8	2
Total	**101**	**78**
Overall total	**179**	

Faculty development

NITheP has embarked on an initiative to engage with faculties and students at more remote centres to enhance research and training in theoretical physics at these centres. In 2012 the following workshops were held as part of this initiative:

1. Prof Robert de Mello Koch (WITS) delivered a talk at UNIVEN on 9 November entitled *Survival Guide for Research*. In his talk Robert asked and answered questions including: "What is research?" "What does a PhD entail?" "What does life in academia entail?" This was very useful to students who were considering postgraduate study. After the talk a discussion with members of staff followed on how to apply to organisations such as the NRF to raise funds and how to plan and compile a research project.
2. NITheP board member and associate representative for the past three years, Prof Robert de Mello-Koch (WITS), presented a gentle introduction to Quantum Field Theory at AIMS from 3 to 21 December. A total of 25 participants attended, including 18 students from UCT. The course motivated quantum field theory, then developed the theory for the scalar field and finally derived the Feynman rules for interacting scalar fields. More information can be found at http://bit.ly/1aKqPwF

Teaching and postgraduate supervision

NITheP's mandate clearly states an involvement of NITheP staff members in teaching and postgraduate supervision. Table 13 shows the 2012 involvement of NITheP staff in teaching, while Table 14 displays the number of Honours (projects), MSc and PhD students under NITheP staff supervision.

Table 13: Hours of teaching by NITheP staff in 2012

Node	Undergraduate (hours)	Honours (hours)	Advanced (MSc/PhD) (hours)	Total
SU	0	36	37	73
UKZN	0	58	0	58
UWC	0	42	0	42
WITS	37	35	0	72
Total	**37**	**171**	**37**	**245**

Table 14: Postgraduate supervision in 2012

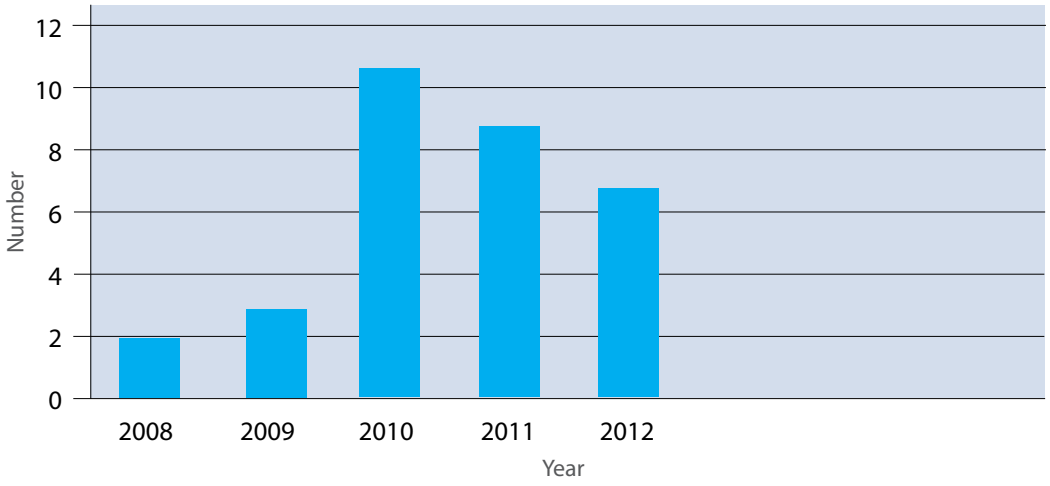
Node	Honours (projects)	MSc	PhD	Total
SU	0	3	5	8
UKZN	0	10	15	25
WITS	0	2	3	5
Total	**0**	**15**	**23**	**38**

The number of MSc and PhD students under NITheP staff supervision who graduated in 2012 is displayed in Table 15.

Table 15: MSc and PhD students under NITheP supervision who graduated in 2012

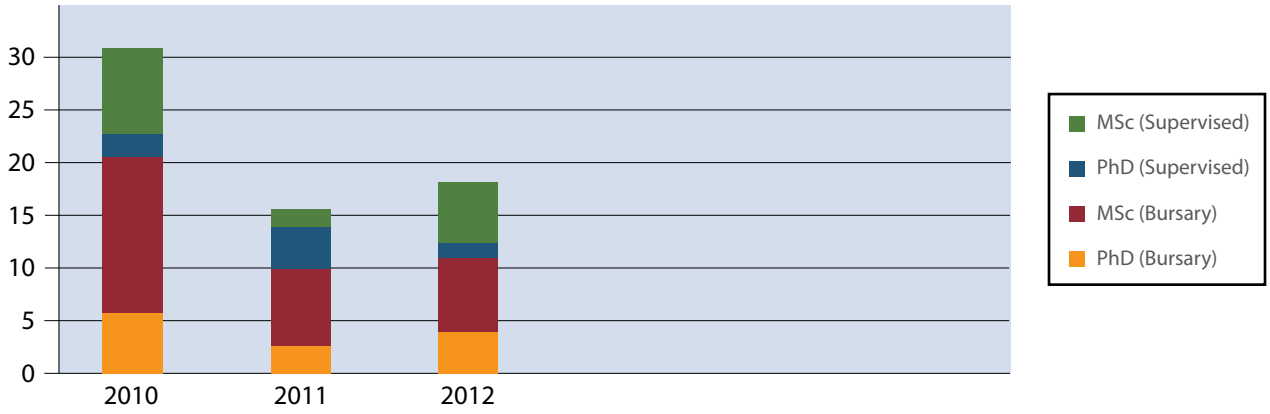
Node	Students	
	MSc	PhD
SU	3	2
UKZN	1	0
WITS	1	0
Total	**5**	**2**

Figure 2: MSc and PhD students under NITheP supervision who graduated in the period 2008 to 2012



The total output of MSc and PhD students who were under NITheP supervision and participated in the bursary programme for the period 2010 to 2012 is shown in Figure 3.

Figure 3: MSc and PhD students under NITheP supervision and in NITheP's bursary programme who graduated in the period 2010 to 2012



Publications

The publication statistics are shown in Table 16, while Figure 4 summarises the trend for the period 2008 to 2012. Figure 5 shows the contribution of the core staff and postdoctoral fellows to the total research outputs for the period 2008 to 2012. This shows a decline, indicating a greater contribution from the NITheP network of associates and visitors to the output from NITheP. This shows that the NITheP model of a national network of researchers is functioning well.

Table 16: Publication output per geographical region for 2012

Geographical region	Publications
Gauteng	33
KwaZulu-Natal	14
Western Cape	24
Total	**71**

Figure 4: Publication trend for the period 2008 to 2012

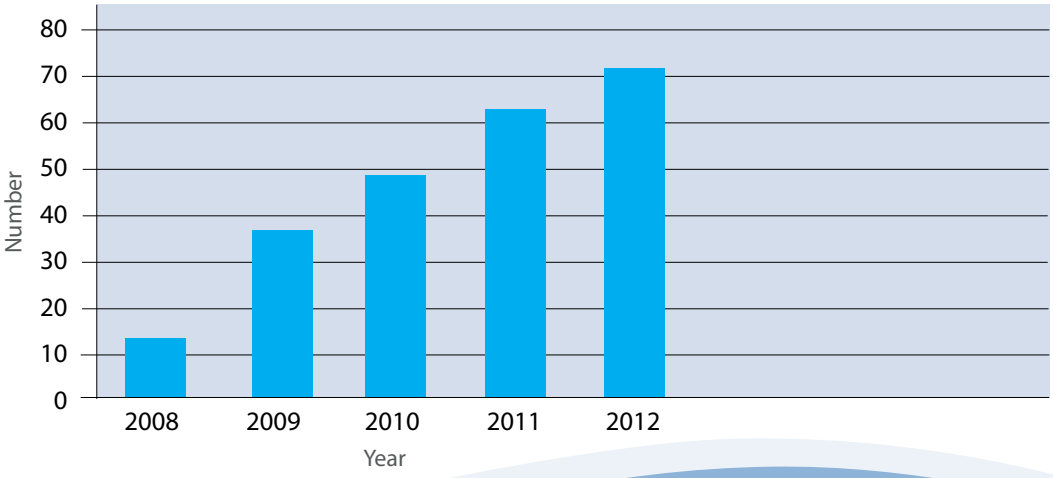
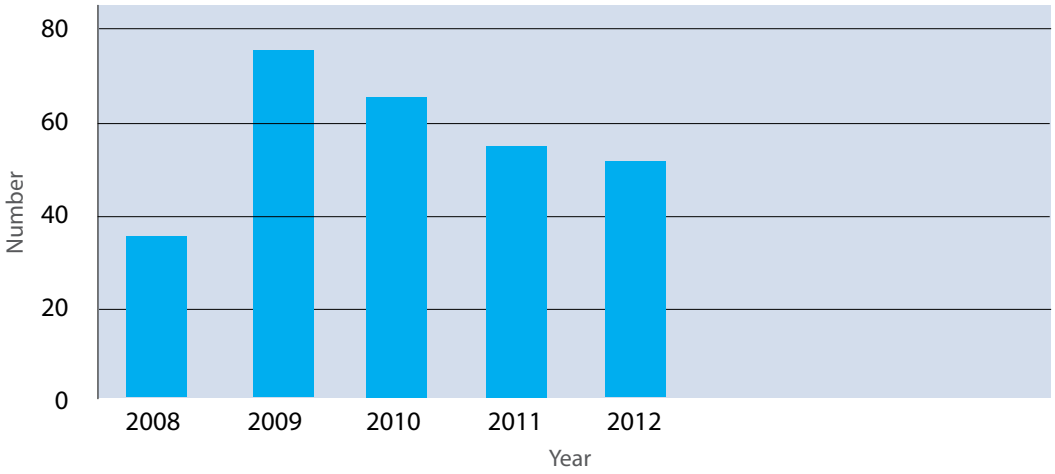


Figure 5: Contribution of core staff and postdoctoral fellows to total number of publications for the period 2008 to 2012



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2. R. C. Andrew, M. Braun and N. Chetty, 'A Theoretical Investigation of the Stability of Crystalline Silicon Dicarbide', *Computational Materials Science,* 55 (2012), 186-91.

3. R. C. Andrew, R. E. Mapasha, A. M. Ukpong and N. Chetty, 'Mechanical Properties of Graphene and Boronitrene', *Physical Review B,* 85 (2012).

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71. Fan Zhang, Jeandrew Brink, Bela Szilagyi and Geoffrey Lovelace, 'Geometrically Motivated Coordinate System for Exploring Spacetime Dynamics in Numerical-Relativity Simulations Using a Quasi-Kinnersley Tetrad', *Physical Review D,* 86 (2012).

Conference proceedings in 2012

1. *Discontinuities in Long-time Dynamics of a Qubit in Weak Coupling Regime: a Model for Arbitrary Slow Decoherence Process of a Qubit*, F. Giraldi and F. Petruccione, Quantum 2012, Torino, 24 May 2012.

2. *Control in Boson-Boson Dynamics through Long Time Scale Discontinuities*, F. Giraldi and F. Petruccione. SAIP Conference 2012, Pretoria, 12 July 2012.

3. *Critical Frequency Control in Open Quantum Systems*, F. Giraldi and F. Petruccione, Quantum Africa 2, northern Drakensburg, 3 September 2012.

4. *Equilibration Times in Closed Long-range Quantum Spin Models*, M. Kastner. New Quantum States of Matter in and out of Equilibrium, Galileo Galilei Institute, Florence, Italy, 10 April to 1 June 2012.

5. *Relaxation Timescales in Closed Long-range Quantum Spin Models*, M. Kastner, 108th Statistical Mechanics Conference, Rutgers University, USA, 16 to 18 December 2012.

6. *Numerical and Analytical Study of a Charge Qubit Interacting with a Semi-infinite 1D Wire,* A. Sheikhan, Innovations in Strongly Correlated Electron Systems, The Abdus Salam International Centre for Theoretical Physics, Miramare, Trieste, Italy, 6 to 17 August 2012.

7. *The Thermodynamics of Dense Non-commutative Fermion Gases,* F. G. Scholtz, IC-MSQUARE, Budapest, 4 to 6 September 2012.

8. *The Intimidation Slide and other Cures for Insomnia. What Will it Take to Test General Relativity?* J. Brink. Gravitational Wave Astronomy Workshop, Pretoria, 31 May 2012.

9. *Renormalisation Running of Masses and Mixings in Universal Extra-dimensional Models*, A. S. Cornell, International Workshop on Discovery Physics at the LHC, Kruger 2012, Kruger Gate Protea Hotel, 6 December 2012.

10. *Open Quantum Random Walks,* I. Sinayskiy, 23rd Chris Engelbrecht Summer School 2012 on Quantum Biology, Salt Rock Hotel, Durban, 18 to 28 January 2012.

11. *Efficiency of Open Quantum Walk Implementation of the Dissipative Quantum Computing,* I. Sinayskiy, SAIP Conference 2012, UP, 9 to 13 July 2012.

12. *Microscopic Derivation of Open Quantum Walks*, I. Sinayskiy, 11th International Conference on Quantum Communication, Measurement and Computing, Vienna University of Technology, Austria, 30 July to 3 August 2012.

13. *Dissipative Preparation of Large W States in Optical Cavities,* I. Sinayskiy, Quantum Africa 2, Mont-Aux-Sources Hotel, northern Drakensberg, 3 to 7 September, 2012.

14. *Dissipative Preparation of W States in Optical Cavities*, I. Sinayskiy, NITheP Workshop on Dissipative Quantum Computing and State Engineering, UKZN, 25 to 28 September 2012.

15. *Dissipative Preparation of W States in Optical Cavities*, I. Sinayskiy, Quantum Optics-VI, Piriapolis, Uruguay, 12 to 16 November 2012.

16. *Dynamics of Ultracold Polar Molecules in a Circularly Polarized Microwave Field,* T. Kirova and A. V. Avdeenkov, TLL/COLIMA 1st Workshop on Manipulation of Light by Matter and Matter by Light, 18 to 19 July 2012, University of Latvia, Riga, Latvia.

2012 Financial Statements

The statement of income and expenditure, cash flow and balance sheet for 2012 are reflected here. It is important to note that NITheP's financial year, which runs from 1 January to 31 December, is out of phase with that of its funders, the National Research Foundation and Department of Science and Technology, which runs from 1 April to 31 March. The practical implication of this is that NITheP receives its grants only in June and November of the financial year. For this reason it is important that NITheP ensures a reserve equal to the bursary values (to be paid in the first semester) plus 50% of salaries and running costs is available at the end of the financial year on 31 December. This reserve is reflected in the statements below.

Balance Sheet at 31 December 2012

	2012 R	2011 R
ASSETS		
NON-CURRENT ASSETS	26 966.28	42 368.83
Computers and office equipment	26 966.28	39 326.51
Intangible assets	-	3 042.32
CURRENT ASSETS	3 155 438.68	3 897 126.21
Other receivables	535 188.24	519 184.57
Petty cash	1 000.00	1 000.00
Stellenbosch University	2 619 250.44	3 376 941.64
TOTAL ASSETS	**3 182 404.96**	**3 939 495.04**
EQUITY AND LIABILITIES		
CAPITAL AND RESERVES	2 919 130.39	3 898 802.54
Accumulated funds	2 919 130.39	3 898 802.54
CURRENT LIABILITIES	263 274.57	40 692.50
Trade and other creditors	263 274.57	40 692.50
TOTAL FUNDS AND LIABILITIES	**3 182 404.96**	**3 939 495.04**

Income Statement for the year ended 31 December 2012

	2012 R	2011 R
INCOME	9 700 525.34	9 188 586.62
Sundry income	-	87 600.00
National Research Foundation grant	9 700 362.00	8 996 000.00
Contribution from Stellenbosch University	-	84 928.00
Contribution from the University of the Witwatersrand	-	19 251.00
Exchange rate gain	163.34	807.62
EXPENDITURE	10 680 197.49	12 703 533.70
Advertisements	197 731.75	-
Audit fees	36 936.00	-
Affiliation and registration	285.00	611 030.97
Amortisation of intangible assets	3 042.32	13 298.35
Books	2 022.22	95 870.62
Bursaries - postgraduate	3 120 252.21	4 570 097.76
Computer materials and software	21 243.04	40 042.79
Conference fees	506 599.58	319 842.15
Consultation	-	10 000.00
Consumables	1 681.00	13 361.09
Contribution to Stellenbosch University: Cold Molecules Workshop	-	122 220.00
Contribution to Stellenbosch University: NIThep Workshop	-	150 000.00
Contribution to Stellenbosch University: Travel	-	20 000.00
Contribution to Stellenbosch University: Electron-Ion Collider Physics Workshop	71 437.00	-
Contribution to Stellenbosch University: International Workshop on Nuclear Spectroscopy	50 000.00	-
Contribution to Stellenbosch University: Visiting Professor	25 000.00	-
Contribution to workshops	20 802.00	30 000.00
Copying and stationery	12 404.45	25 611.48
Depreciation	12 360.23	41 230.23
Entertainment	81 795.52	125 530.82
Furniture and equipment not capitalised	11 231.19	62 768.89
Levies	25 873.00	20 793.22
Marketing and promotions	49 113.62	53 202.88
Office administration	26 438.27	11 583.09
Postage, telephone and fax	61 657.56	134 543.90
Prizes and medals	4 000.00	3 000.00
Rent paid for facilities	-	212 000.00
Repairs and maintenance	1 196.80	240.15
Salaries	4 680 930.81	4 588 540.13
Sponsorships and donations	-	-
Sundry expenses	14 251.32	10 067.02
Translation work	-	250.00
Travel and accommodation	1 614 397.74	1 404 625.50
SHORTAGE FOR THE YEAR BEFORE TRANSFERS	**(979 672.15)**	**(3 514 947.08)**
TRANSFERS BETWEEN NODES	-	-
Transfer to KwaZulu-Natal	(2 407 559.33)	(2 351 299.70)
Transfer to Gauteng	(1 494 046.16)	(1 717 514.41)
Transfers from Stellenbosch	3 901 605.49	4 068 814.11
SHORTAGE FOR THE YEAR	**(979 672.15)**	**(3 514 947.08)**

Cash Flow Statement for the year ended 31 December 2012

	2012 R	2011 R
CASH FLOW FROM OPERATING ACTIVITIES		
Shortage for the year	(979 672.15)	(3 514 947.08)
Adjustment for:		
Depreciation and amortisation	15 402.55	54 528.58
Operating loss before working capital adjustments	(964 269.60)	(3 460 418.50)
Working capital adjustments	206 578.40	54 048.69
(Decrease)/Increase in trade and other receivables	**(16 003.67)**	**215 435.66**
Increase/(decrease) in trade and other payables	**222 582.07**	**(161 386.97)**
Cash utilised in operations	(757 691.20)	(3 406 369.81)
Interest received	-	-
NET CASH FLOW FROM OPERATING ACTIVITIES	**(757 691.20)**	**(3 406 369.81)**
CASH FLOW FROM INVESTMENT ACTIVITIES		
Computers and office equipment purchased	-	(24 499.80)
Decrease in amount owed by Stellenbosch University	757 691.20	3 430 869.61
NET CASH FLOW FROM INVESTMENT ACTIVITIES	**757 691.20**	**3 406 369.81**
NET INCREASE IN CASH AND CASH EQUIVALENTS	-	-
CASH AND CASH EQUIVALENTS AT THE BEGINNING OF THE YEAR	1 000.00	1 000.00
CASH AND CASH EQUIVALENTS AT THE END OF THE YEAR	**1 000.00**	**1 000.00**