Annual report: 1 January to 31 December 2017

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Abbreviations

AIMS	African Institute for Mathematical Sciences
CoE	Centre of Excellence
CPUT	Cape Peninsula University of Technology
CSIR	Council for Scientific and Industrial Research
DST	Department of Science and Technology
DVC	Deputy Vice-Chancellor
HartRAO	Hartebeesthoek Radio Astronomy Observatory
ICTP	International Centre for Theoretical Physics
iThemba LABS	iThemba Laboratory for Accelerator Based Sciences
MANCO	Management Committee
NASSP	National Astrophysics and Space Science Programme
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
SAC	Scientific Advisory Committee
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
TP	Theoretical Physics
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
ICTP	International Centre for Theoretical Physics

Director's report

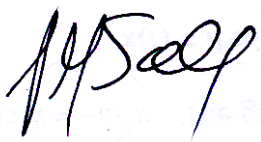
2017 was in many respects a very challenging year for NITheP, despite a successful and positive 5 year review in February,

A new contract for NITheP had to be negotiated with the DST and NRF, which delayed the flow of funds to NITheP until late in 2017. Although bridging finance was provided by Stellenbosch University, there was a period of 3 months in which NITheP had no funding. This delayed the payment of bursaries, which caused considerable hardship to students. Likewise the uncertainty around continued funding placed tremendous stress on staff. Eventually a three year contract for the period 1 April 2017- 31 March 2020 was put in place at funding levels 25% lower than in previous years. This has put tremendous pressure on the 2017 budget and a moratorium had to be placed on several programs to absorb the budget cut. As part of the negotiations with the DST and NRF, a process to determine the way ahead after March 2020 has also been initiated.

Despite these disruptive issues, 2017 was still a very active and productive year. A range of training and research workshops, schools, internships and many other science engagement activities took place. These are fully reported on below. Remarkably, 2017 was also a very productive year in terms of scientific publications with a total of 84 publications in ISI journals.

As in the past, one of the highlights of 2017, was NITheP's continued good performance as measured by the Nature's Index of Top Institutions. NITheP occupies the 4th slot in Africa in the Physical Sciences and is under the top 10 in all subject categories.

We are looking ahead at a new phase in NITheP's life in which there will be an even stronger emphasis on the development of high level human capacity and international competitiveness.



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 (CoE), which is subject to the notarisation of a binding contract between the granter, the National Research Foundation (NRF), 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.

Governance and Structure

- **Governance**

The governance structure, as set out in the governance document for a national CoE, makes provision for the establishment of a Steering Committee, Scientific Advisory Committee and Management Committee (MANCO). The composition of these three core governance committees was as follows on 31 December 2017:

Steering Committee members:

- Dr Rob Adam (Director, Square Kilometer Array)
- Prof Eugene Cloete (Deputy Vice-Chancellor: Research, SU) (Chair)
- Prof Barry Green (Director, African Institute for Mathematical Sciences)
- Dr Joseph Kirui (HOD Physics Department, University of Venda)
- Prof Azwinndini Muronga (NMU Executive Dean: Faculty of Science)
- Prof Francesco Petruccione (NITheP Deputy director, UKZN; SARChI: Quantum Information Processing and Communication)
- Prof João Rodrigues (NITheP Deputy director, WITS; Head: School of Physics)
- Mr Nathan Sassman (Director: NRF Research Chairs and Centres of Excellence)
- Prof Frederik Scholtz (NITheP Director)
- Prof Amanda Weltman (UCT and SARChI: Physical Cosmology)

Scientific Advisory committee (SAC):

- Prof Sylvester James Gates (University of Maryland, USA)
- Prof Jan Govaerts (Catholic University Louvain, Belgium)
- Prof Sir Peter Knight (Imperial College of London, UK)
- Prof Frans Pretorius (Princeton University, USA)
- Prof Kennedy Reed (Lawrence Livermore National Laboratory, USA)
- Prof Shahin Sheikh-Jabbari (Institute for Research in Fundamental Sciences, Iran)
- Prof Neil Turok (Perimeter Institute, Canada)
- Prof Fernando Quevedo (International Center for Theoretical Physics, Italy)

Management committee (MANCO):

- Prof Alan Cornell (WITS)
- Prof Francesco Petruccione (NITheP Deputy director, UKZN)
- Prof João Rodrigues (NITheP Deputy director, School of Physics, WITS)
- Prof Frederik Scholtz (NITheP Director; MANCO and SAC Chair)

- **Staff**

The staff profile of NITheP as on 31 December 2017 is shown in Table 1.

Table 1: Staff profile on 31 December 2017

Position	Node	Number of positions (appointment)
Director	SU	1 (five-year contract)
Deputy Director	WITS/UKZN	2 (five-year contracts, 25%)
Chief Researcher	SU	2 (five-year contracts)
Researcher	SU/WITS	2 (five-year contracts, WITS from Sept)
Senior administrative officer	SU	1 (five-year contract)
Secretary	UKZN	1 (five-year contract)
Total		**9**

- **Postdoctoral fellows**

The postdoctoral fellows per node as on 31 December 201 are shown in Table 2. All positions comprise two-year contracts.

Table 2: Postdoctoral fellows on 31 December 2017

Node	NITheP funded	Externally funded
SU	**1**	**0**
UKZN	**2**	**2**
WITS	**2**	**5**
Total	**5**	**7**

Activities in 2017

- **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 the inception of NITheP and 2017 was no exception.

NITheP has continued to deliver a service to the theoretical physics community by acting as the communication channel for various parties within the field. The community has been interacting with one another through the communication channels provided by NITheP. Job and study opportunities in SA and abroad have been channelled through NITheP to the SA theoretical physics community. SA theoretical physics workshops have been advertised abroad in order to attract paying international delegates to NITheP workshops, in addition to NITheP supported South African students. NITheP renders a service by being a distribution channel for information dissemination within the South African theoretical physics community and also two way communication between SA and the international theoretical physics community.

NITheP Website www.nithep.ac.za
The current website platform has become outdated. Due to the process currently underway to determine the future of NITheP, it does not make sense to embark on building a new website for NITheP at this point in time. As soon as the way forward has been clarified, work will commence to create a fresh modern website that is well integrated with social media platforms, that is also appealing to this generation of students.

NITheP database and e-mail distribution list
550 subscribers receive news in various categories including news on regional seminar announcements, workshop announcements, bursary/internship calls, job and study opportunities as well as general news of interest to the South African and African theoretical physics communities.

NITheP Facebook page @NITheP
881 Facebook Followers and visitors post comments and form discussion groups around various topics of interest. Events and visitors photo's of workshops are shared via this platform.

NITheP Twitter account @NIThePSA
191 followers view announcments and dissemination of news within the community. Followers include @womeninstemi, @africanphysics, @NRF_SAASTA, @BlackPhysicists, @SAJS_Official and @NaturePhysics.

LinkedIn
NITheP connects with 841 people throughout the South African and International theoretical physics community, including NITheP bursary alumni.

➢ Networking

○ Associate programme

In order to achieve the strategic goals of NITheP, it is crucial to maintain a national network throughout South Africa. In 2017, the successful NITheP Associate programme continued growing.

NITheP has 85 Associates across all Universities in South Africa:

- 76 Regular/Senior Associates
- 5 Strategic Associates
- 4 Institutional Associates

Associates have access to the NITheP Visitor, Mobility and Workshop programmes through an annual Request for Proposal (RFP) system.

Table 3: Associates on 31 December 2017

Regular/Senior Associates (76)	
Prof Jacek Banasiak	UKZN
Prof Igor Barashenkov	UCT
Dr Bruce Bartlett	SU
Prof Bruce Bassett	AIMS/SAAO/UCT
Prof Nigel Bishop	RU
Prof Moritz Braun	UNISA
Dr Jeandrew Brink	SU
Prof Erwin Brüning	UKZN
Prof Nithaya Chetty	UP/NRF
Dr Cynthia Chiang	UKZN
Dr Chris Clarkson	UCT

Prof Jean Cleymans	UCT
Prof Sergio Colafrancesco	WITS
Prof Alan Cornell	WITS
Dr Álvaro de la Cruz Dombriz	UCT
Prof Robert de Mello Koch	WITS
Prof Cesareo Dominguez	UCT
Prof Peter Dunsby	UCT
Dr Rocco Duvenhage	UP
Prof Hans Eggers	SU
Prof George Ellis	UCT
Dr Eugene Engelbrecht	NWU
Prof Arthur Every	WITS
Prof Stefan Ferreira	NWU
Prof Kevin Goldstein	WITS
Dr Filippo Giraldi	UKZN
Prof Dieter Heiss	SU
Prof Manfred Hellberg	UKZN
Dr Gregory Hillhouse	UZULU
Dr Shinji Hirano	WITS
Dr William A Horowitz	UCT
Prof Vishnu Jejjala	WITS
Prof Daniel Joubert	WITS
Prof Steven Karataglidis	UJ
Dr Hannes Kriel	SU
Prof Thomas Konrad	UKZN
Dr Julien Larena	RU

Prof Mantile Lekala	UNISA
Dr Yin-Zhe Ma	UKZN
Prof Roy Maartens	UWC
Prof Richard Mace	UKZN
Prof Sunil Maharaj	UKZN
Prof Daniel Makinde	CPUT
Dr Eric Maluta	UNIVEN
Dr Joseph Medved	RU
Dr Shazrene Mohamed	SAAO
Prof Kavilan Moodley	UKZN
Dr Thuto Mosuang	University of Limpopo
Prof Kristian Müller-Nedebock	SU
Prof Azwinndini Muronga	NMU
Prof Jeff Murugan	UCT
Dr Giuseppe Pellicane	UKZN
Prof André Peshier	UCT
Dr Denis Pollney	RU
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 Jonathan Shock	UCT
Prof Jonathan Sievers	UKZN

Dr Ilya Sinayskiy	UKZN
Dr Izak Snyman	WITS
Dr Du Toit Strauss	NWU
Prof Mark Tame	UKZN
Dr Gary Tupper	UCT
Dr Hermann Uys	NLC, CSIR
Prof Raoul Viollier	UCT
Prof André Weideman	SU
Prof Herbert Weigel	SU
Prof Heribert Weigert	UCT
Prof Amanda Weltman	UCT
Prof Konstantinos Zoubos	UP
Dr Caroline Zunckel	UKZN
INSTITUTIONAL ASSOCIATES (4)	
UCT-CERN (UCT)	
Centre for Theoretical Physics (UCT)	
Cosmology Group (UCT)	
Centre for Space Research (NWU)	
STRATEGIC ASSOCIATES (5)	
AIMS	
DST/NRF CoE in Strong Materials	
HartRAO	
iThemba LABS	
University of Venda	

Institutional representation of network:

Type of Institution	% of this type of institution covered by network
Traditional: UCT, UFH, UFS, UKZN, UL, NWU, UP, RU, SU, UWC, WITS	82%
Comprehensive: UJ, NMMU, UNISA, UNIVEN, WSU, UNIZULU	50%
Other: AIMS, SAAO, CSIR, Strong Materials, HartRAO, iThemba	83%
Historically disadvantaged: UFH, UL, UNIVEN, WSU, UWC, UNIZULU	50%

Zero representation at Technical Universities as they do not offer Theoretical Physics.

Associate workshop

The annual NITheP associate workshop was not held during 2017, due to the funding crisis experienced during 2017 (no money was available at the time when planning was supposed to have commence to arrange the Associate workshop), also, due to a lack of clarity on the future of NITheP. An Associate workshop has been scheduled to be held during 2018, in order to update Associates on the current status of NITheP, and for a scientific programme to take place. This event is also a very good networking event for Associates from all over South Africa to meet and discuss Theoretical Physics topics.

During previous years, the Associate workshop started with the customary meeting on general Associate matters, followed by the annual Associate meeting. The second day consisted of a scientific programme, with three talks of one hour each.

Prof Alan Cornell (WITS) served as the Associate representative on the NITheP management committee during 2017.

- **International linkage**

NITheP currently has agreements with the following international institutes:

- International Centre for Theoretical Physics (ICTP) in Trieste, Italy
- International School for Advanced Studies (SISSA) in Trieste, Italy

➢ Request for Proposal (RFP) system

The RFP program is a competitive, proposal driven program through which NITheP gives associates and staff access to NITheP resources and includes the mobility, long-term visitor, workshop and research programmes.

Table 4 summarises the support given to staff and Associates under the RFP program during 2017. Greater detail on each activity is listed further below under the appropriate headings. It should also be noted that although some of the activities will take place in 2018, they are all supported from the 2017 budget.

Table 4: Summary of proposals supported under the RFP program in 2017

Type of activity	Number of proposals
Long-term visitors	5 (11 visitor months)
Mobility	1
Schools	1
Capacity development workshops	3
Research workshops	8

➢ 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 were strongly motivated and justified, transport costs.

Two such proposals were supported under the Mobility programme during 2017

➢ Visitors

A vibrant visitor programme is vital for the success of NITheP. 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 and 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 through their South African NITheP associate collaborator.

Visitors interact with researchers and often publish a paper following a visit, present guest lectures and special courses.

The NITheP short-term visitor programme supported 44 visitors during 2017, and the details are indicated in Table 5.

Table 5: Short-term visitors who visited NITheP in 2017

NITheP node	Short-term visitors
SU	9
UKZN	27
WITS	14
Total	50

Toal short-term visitors since 2009 until 2017:
419

Average short-term visitors per annum:
47

Visitor	Home Institute (affiliation)	Host (affiliation)	Term (month)	Publication
Prof Martin Bucher	Université Paris 7/Centre National de Recherche scientifique	Prof Kavilan Moodley	3	1
Prof Karl Schilcher	Johannes Gutenberg University of Mainz, Germany	Prof Cesareo Dominguez	1,5	2
Prof Guenter Wunner	1. Inst. Theor.Physics, Univ.Stuttgart	Prof Dieter Heiss	1,5	2
Prof Massimo Boninsegni	University of Alberta, Canada	Dr Fabio Cinti	2	1
Dr Jad Halimeh	Max-Planck-Institut für Physik	Prof Michael Kastner	3	1

	komplexer Systeme			
Total			**11**	**7**

Table 6 summarises the long-term visitors who were supported under the RFP system, which totalled 18 visitor months.

Table 6: Long-term visitors supported under the RFP system in 2017

➢ Capacity Development Workshops

Capacity development and transformation in theoretical physcs in South Africa as well as Africa, is very much part of the NITheP mandate.

This involvement continued in 2017 with the following capacity development workshops:

- Hot and Dense matter in heavy-ion collisions, astrophysics and cosmology
- Workshop on High Energy Particle Physics
- Winter School on Computational Physics

➢ Bursaries

The application statistics for 2018 on the date of closure (31 January 2018) are shown in tables 8 and 9. For comparison the corresponding statistics for 2017 are also shown.

Table 8: Application statistics for SA citizens for 2017 and 2018

Degree	2017	2018
Honours	17	0
MSc	16	19
PhD	12	7
Total	**45**	**26**

Table 9: Application statistics by gender and race for 2017 and 2018

Degree	White(%)		Black(%)		Female(%)	
	2017	2018	2017	2018	2017	2018
Honours	41	N/A	59	N/A	35	N/A
MSc	38	42	62	58	13	37
PhD	58	43	42	57	0	29

A total of 29 bursaries were awarded in 2017.

Bursaries awarded in 2017

Level	Number	Amount allocated per bursary (R)	Budgeted Cost	Actual Cost
Hons.	2	50 000	100 000	100 000
M.Sc.	13	80 000	1 040 000	850 000
Ph.D.	14	100 000	1 400 000	1 350 000
	29		**2 540 000**	**2 300 000**

Bursary holders per institution

Institution	Hons.	M.Sc.	Ph.D.	Total
Stellenbosch	0	1	1	2
Cape Town	1	4	2	7
Witwatersrand	0	3	8	11
UKZN	0	0	1	1
UNISA	0	1	0	1
Venda	0	1	0	1
Northwest	1	0	1	2
Pretoria	0	3	1	4
Totals	**2**	**13**	**14**	**29**

*only SU offers Theoretical Physics as from Honours leve. All other Universities start TP specialization as from MSc level.

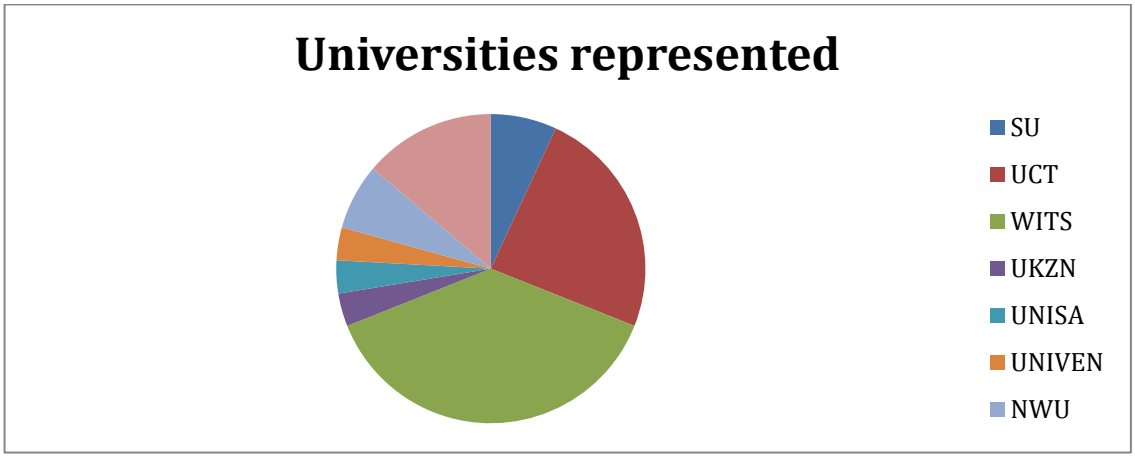


Table 9
Bursary holders by race and gender in 2017

Degree	White		Black		Coloured		Indian	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Hons.	0	0	2	0	0	0	0	0
M.Sc.	6	0	4	0	1	0	2	0
Ph.D.	6	2	6	0	0	0	0	0
Totals	**12**	**2**	**12**	**0**	**1**	**0**	**2**	**0**

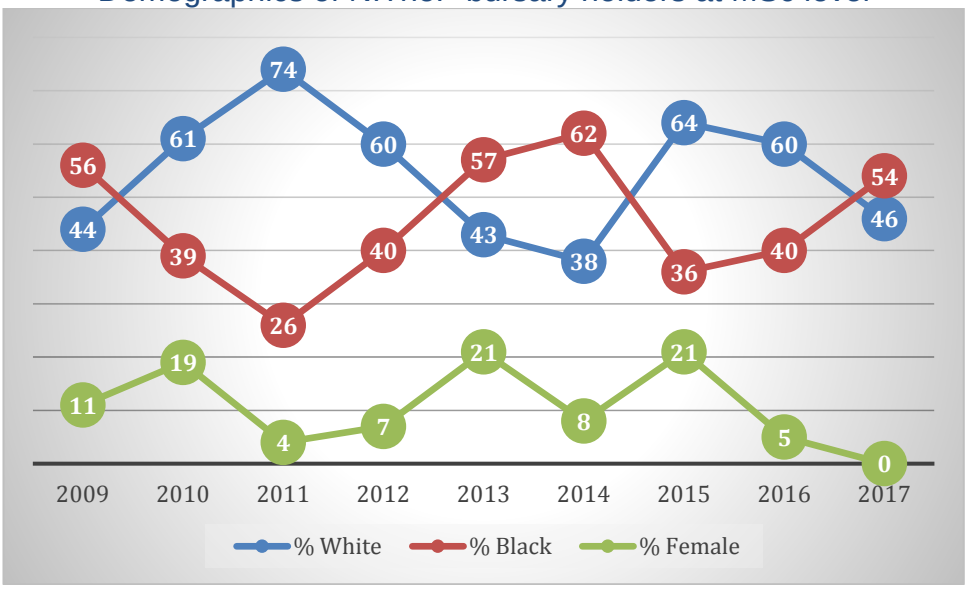
Table 9 shows the details by race and gender. The bursary demographic profile shows an encouraging trend in that it is now dominated by bursary holders from previously disadvantaged communities.

- 52% of NITheP bursary holders are Black
- 7% of NITheP bursary holders are female

Table 9 also indicates that the sustained efforts of NITheP for the past 9 years engaging particularly with students from HDI Universities, has led to an increased success rate in the uptake of NITheP bursaries, compared to the situation 9 years ago.

It is important to note that the gender profile remains skewed, as is the international phenomena with low levels of female participation in the mathematical sciences. This is particularly pressing in the black and coloured communities and NITheP aims to continue addressing this matter during 2018.. One such measure to assist in driving the transformation agenda, is that it NITheP requires all workshop organising committees and lecturer profiles to include black and female members. Workshop organisers who do not adhere to these strict guidelines, will not be supported by NITheP programmes in the future.

Demographics of NITheP bursary holders at MSc level



Demographics of NITheP bursary holders at PhD level

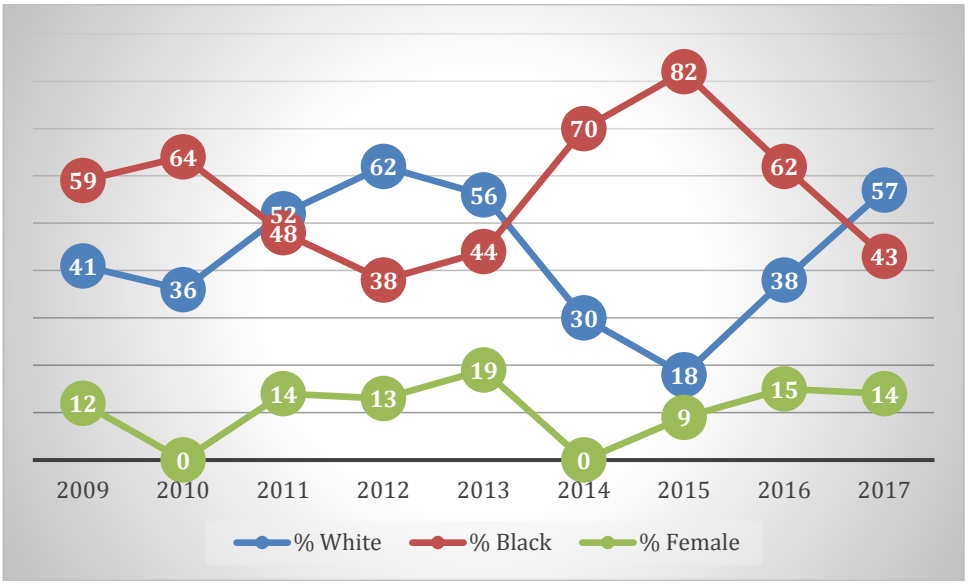
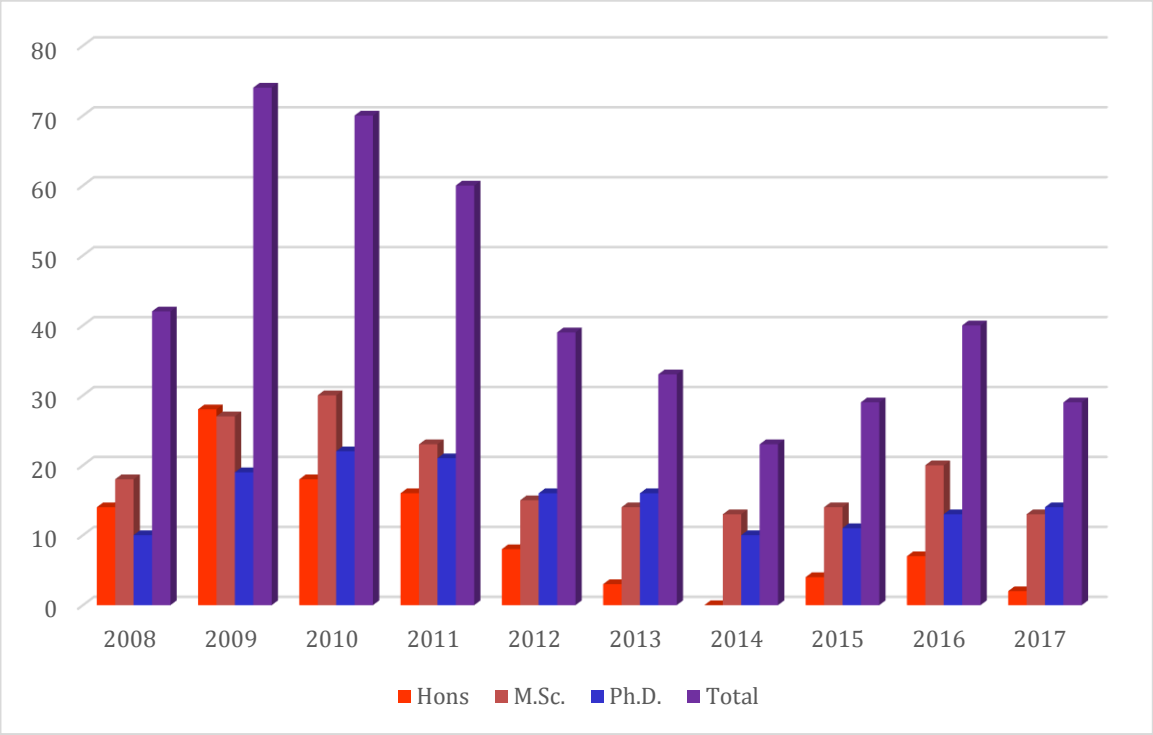
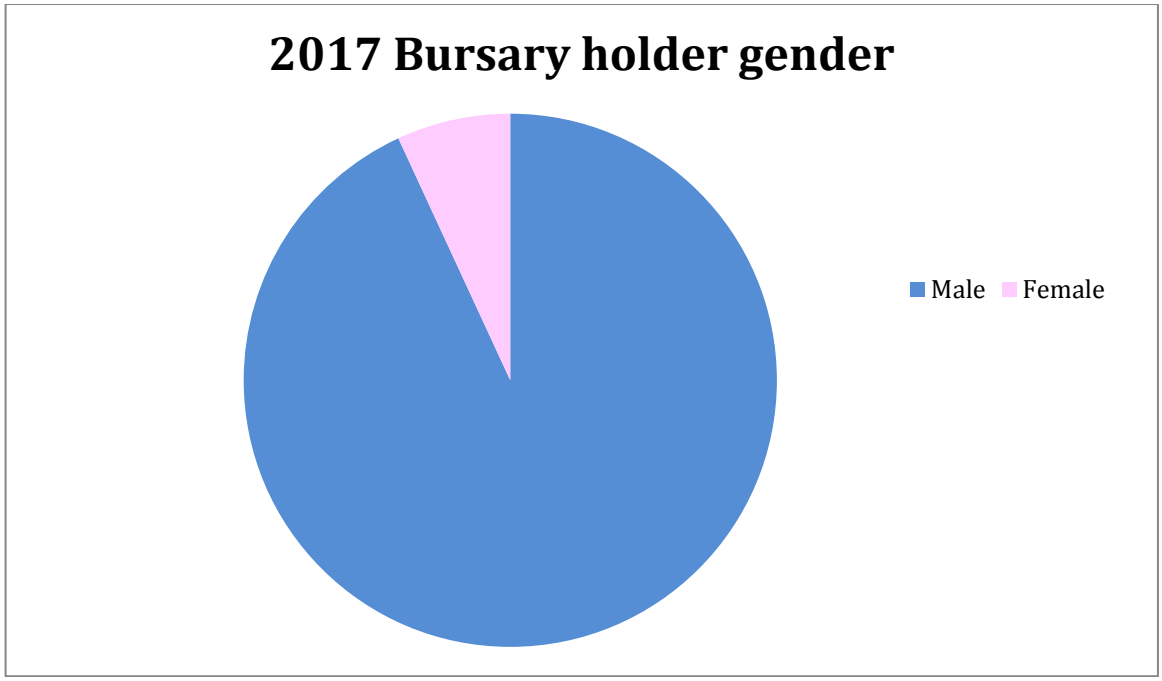
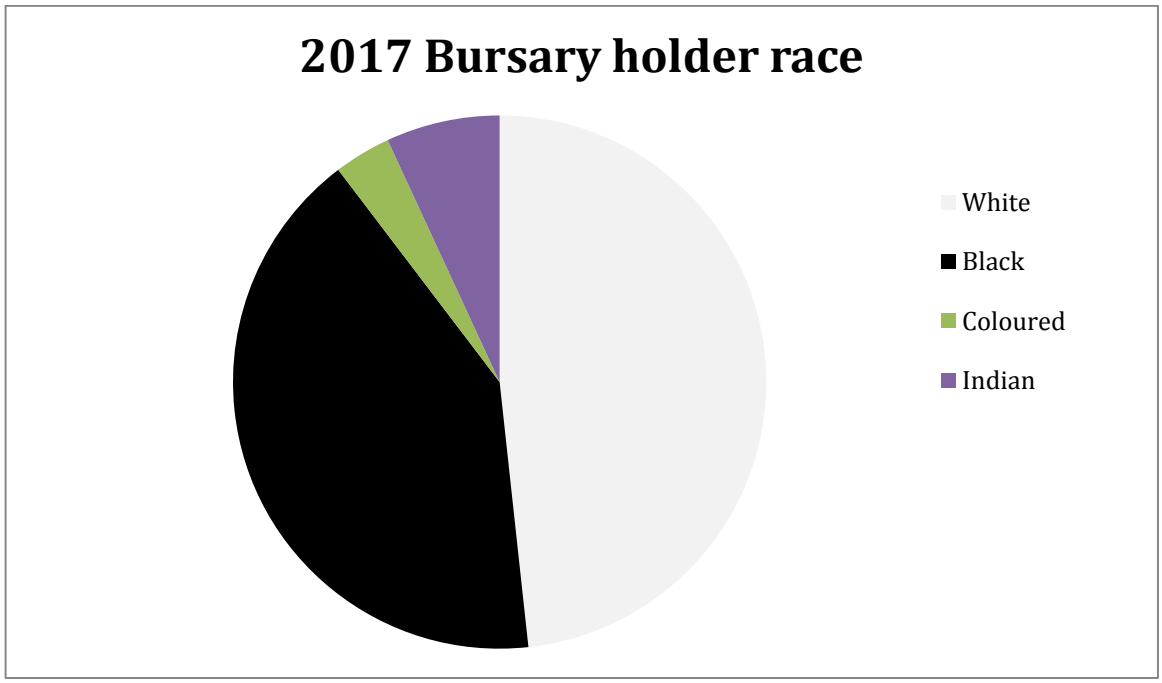


Figure 1: Change in composition of bursary pool in the period 2008-2017







Bursary holder workshop

The NITheP two-day annual bursary holder workshop was held at the NITheP offices in Stellenbosch on during November 2017. MSc and PhD students presented 20-minute talks of their current research/project and took questions from their fellow students. This workshop gives students an excellent opportunity to learn from one another and to hone their skills in a non-threatening, encouraging environment. In general the feedback was that

students appreciate the opportunity to have learnt more about presenting their work, gaining presentation skills as well as networking with fellow NITheP bursary holders.

Each year a member of the corporate or financial industry is invited to speak with the students about what opportunities are available to them in the cororate world, once they have completed their studies.

The event is open to the entire community to attend (at own cost). Normally a number of Supervisors of the students also attend the annual events. All NITheP researchers attend the event and act as judges along with the Supervisors that are in attendance.

Two prizes are awarded each year:

R3000 prize for best MSc presentation (Robert Moerman)
R4000 prize for best PhD presentation (Stefan Buddenbrock)

- **Internships**

The internship programme continued during 2017 to be an excellent method of developing students as well as targeting students from HDI universities in order to accelerate transformation.

This flagship programme has two components. The first enables students at Honours or MSc level to join NITheP workshops and to 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 or early master's level, to join NITheP staff or associates during June/July or November/December 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 advance.

The benefits are that NITheP provides a training opportunity, often under the guidance of a leading researcher. At the same time, the pressure of project supervision on departments is alleviated. Students get to visit other universities that might otherwise not have been possible, and meet possible new supervisors for a further degree or a new field of interest. It also often happens that an internship student realises that his/her current Supervisor or field is interest is indeed what interests them most.

Students apply to NITheP, following an annual call for Internship applications that is sent out. Typically NITheP supports the students who pass the screening process for this programme in terms of travel, accommodation and subsistence costs. There are 31 internship topics available for prospective internship students to choose from.

Table 10 summarises the details regarding the Internship programme during 2017. Particularly encouraging is the considerable number of interns who continue with a higher degree in Theoretical Physics.

Please note: due to the financial limitations it was not possible for Internships to be organized during the June/July recess, as there was no funding available at that time. When the money became available towards the end of the year, due to a limited amount of time being available, one group of internship students were arranged to work with Prof Azwinndini Muronga (NMU). A Star Early edition newspaper article was published on January 9th 2018, about the work of the group.

Table 10: Internship statistics for 2017

Student's home institute (host institute)	Number of students	Number of students earning credits	Students who continued with higher degree in TP
UL (NMU)	3	3	2
UNIVEN (NMU)	2	1	2
UKZN (NMU)	1	1	1
UJ (NMU)	1	1	1
UP (NMU)	1	0	1
SU (NMU)	1	0	1
Total	9	6	8

Table 11 demonstrates demographics of the NITheP Internship students.

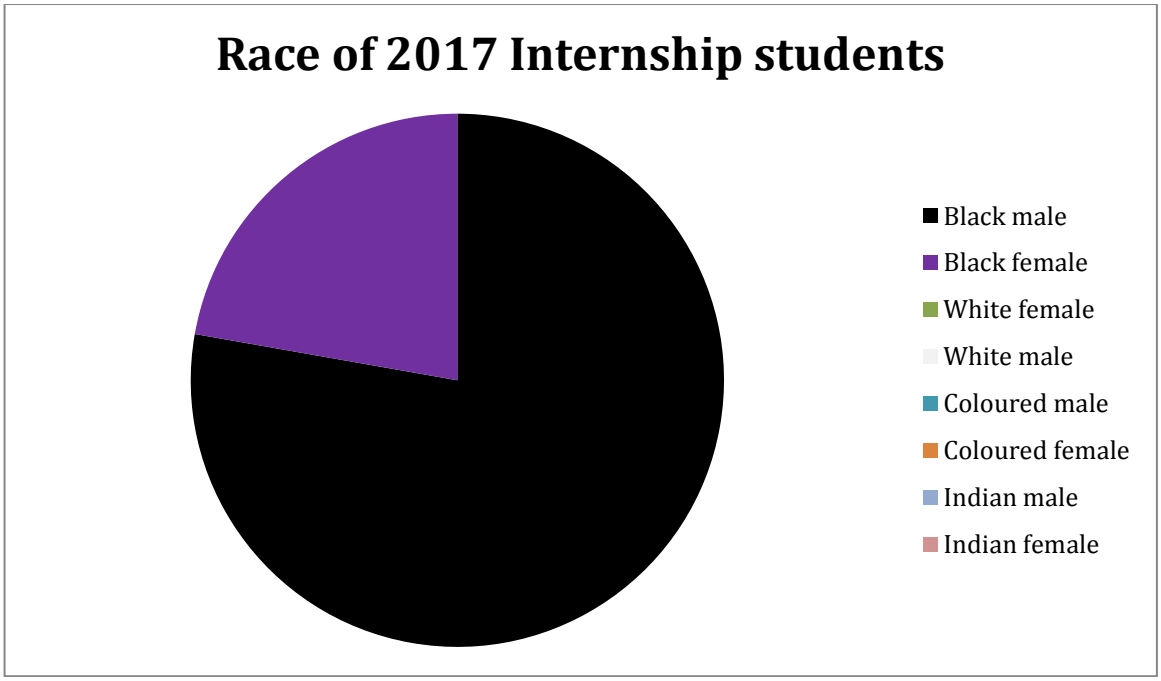
Table 11: Internship students per race and gender 2017

White		**Black**		**Coloured**		**Indian**		**Total**
Male	Female	Male	Female	Male	Female	Male	Female	
0	0	7	2	0	0	0	0	9

Demographics Summary:

100% of NITheP Internship students were South African
100% of NITheP Internship students were Black

- Total black internship students 100%
- Total female internship students 22%



- **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.

  No travel grants were awarded during 2017 as a moratorium was placed on all travel as an austerity measure.

- **Outreach, community service and the popularisation of science**

  - **Public talks**

  No public talks could be arranged during 2017 due to financial situation.

  - **Eskom Expo for Young Scientists, national finals in Johannesburg**

For the sixth consecutive years in a row, NITheP sponsored two prizes of R2000 each at the Eskom Expo national finals. The two prizes were:

- Best Physics
- Best Mathematics projects.

In the past, NITheP Researchers offered their time to adjudicate the learners' projects.

During 2017 this did not take place.

- **Annual road trip of the SU Physics department Student Outreach group**

In collaboration with the following sponsors NITheP has sponsored this outreach event for a previous six year, but NITheP could not partake during 2017.

- Optical Society of America (OSA)
- The Dean's Office for the Faculty of Natural Sciences, Stellenbosch University
- Department of Physics, Stellenbosch University
- iThemba LABS

A group of post-graduate students from the Laser Research Institute, the Institute for Theoretical Physics and the greater part of the departments' student body team up together on an annual outreach road trip. The aim of the trip each year is to visit schools in underprivileged communities in areas that are not typically reached by outreach efforts of other organisations. Typically during such a school visit, popular physics demonstrations are given and learners are informed about career options available to them in the STEM fields. The feedback that had been received in the past, from teachers and leaners has been overwhelmingly positive year after year.

Annual SAIP Conference

NITheP has attended the annual South African Institute of Physics (SAIP) conference on a bi-annual basis for the past nine years. For the same period of time, NITheP has been present on the back cover of the SAIP Book of Abstracts that all delegates receive.

NITheP hosts and funds an exhibition stand at the SAIP conference on a bi-annual basis. The purpose of which is to provide a public relations and communication service to the theoretical physics community as well as facilitation of networking amongst theoretical physics community members and students. Since the SAIP took place in Stellenbosch, NITheP did participate in this event, but due to a lack of funding, the backpage advertisement will not be taken during 2018, which will be a break with the tradition of the past 9 years.

Service to the Theoretical Physics community

- Job shadowing:

Four job shadowing opportunities were created for high school learners during 2016. These come about from requests by schools or learners themselves indiating that these individuals have expressed an interest in following a career in Theoretical Physics.

- **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 following 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)

  - **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 TP or broader physics community to propose a topic, speakers and organising committee for the school.

    In 2015 the following schools, workshops and short research programmes were supported under the RFP system. In addition to the grants made by NITheP, an additional amount of **R**1 717 500 was leveraged through these workshops/conferences.

    Schools and Workshops

    The 28th Chris Engelbrecht Summer School, titled "Quantum Machine Learning". took place from 23rd January - 1st February 2017 at the Alpine Heath Resort Drakensberg, South Africa.

    Prof Francesco Petruccione submitted the proposal for this School.

The website with more information can be seen here:
https://www.quantummachinelearning.org/qml-summer-school-2017.html

"Quantum machine learning summarises research that looks for synergies between the disciplines of quantum information processing and machine learning. An important question is for example how quantum computers can be used for automated prediction tasks such as image recognition and natural language processing. Another approach uses methods developed in machine learning to learn about quantum systems, for example in settings where we can only gain limited information from a quantum system through measurements".

Quantum Machine Learning website

Organizing Committee	
Name	Affiliation
Prof Francesco Petruccione (Chairman)	NITheP & UKZN
Maria Schuld	UKZN

Invited Speakers	
Name	Affiliation
Uwe Jaekel	University of Applied Sciences Koblenz)
John Realpe-Gomez	(NASA)
Katja Ried	University of Innsbruck
Enrique Solano	University of the Basque Country
Peter Wittek	(Institute for Photonic Science ICFO)

Chris Engelbrecht Summerschool 2017 group photo to be placed here.

The following Workshops took place under the Request for Proposal Programme

Capacity Development Workshops/Special Courses

Hot and dense matter in heavy-ion collisions, astrophysics and cosmology.
Workshop on High Energy Particle Physics
Winter School on Computational Physics

Short Research Programmes

Entanglement and the web of dualities

Research Workshops
Cosmology on Safari
Algebras, Fields and Space – time
Open Quantum Walks
Fundamental Physics of the SKA
Combinatronics, Quantum Field Theory and Strings
Johburg-8

The participation in these events is summarised in Table 12

Table 12: Participation in NITheP-organised events in 2017

Event	Student participants (including Postdocs)				Ordinary participants				Invited speaker	Total participants	NITheP Grant (R'000)	Funds Levered (R'000)
	South African	Other African countries	International	Total	South African	African	International	Total				
SCHOOLS												
28th Chris Engelbrecht Summer School	25	4	15	44	0	0	20	20	5	69	300	126,5
CAPCITY DEVELOPMENT WORKSHOPS												
International Workshop on Hot and Dense Nuclear and Astrophysical Matter (Prof Muronga)	20	0	0	20	0	0	0	0	5	25	125	160
Workshop on High Energy Particle Physics (Prof Cornell)	33	3	0	36	15	1	0	16	4	56	125	70
2017 NITheP School on Computational Physics (Prof Touchette/Dr Cinti)	23	2	0	25	0	0	0	0	3	28	125	52
RESEARCH WORKSHOPS												
Cosmology on Safari (Prof Sievers)	20	10	25	55	0	0	35	35	5	95	60	70
The First Mandelstam Theoretical Physics School and Workshop (Prof de Mello Koch)	14	1	9	24	24	1	9	34	6	64	125	375
Open Quantum Walks (Prof Sinayskiy)	6	1	3	10	5	0	0	5	6	21	125	28
Fundamental Physics with the SKA (Prof Weltman)	3	2	1	6	10	10	53	73	16	95	125	600
Combinatronics, Quantum Field Theory and Strings (Prof Hirano)	3	3	2	6	1	1	15	17	13	86	125	35

8th Joburg Workshop on String Theory: Black Holes and Entanglement (Prof Jejalla)	29	0	7	36	3	0	16	19	8	63	125	76
General Relativistic effects in cosmological surveys (Prof Maartens)	3	3	20	26	5	0	0	5	9	40	125	125
Total	179	29	82	**288**	63	13	148	**224**	**80**	**642**	1485	1717,5

Faculty development

NITheP has embarked on an initiative to engage with faculties and students at more remote centres to fast track transformation as well as to enhance research and training in TP at these centres.

Teaching and postgraduate supervision

NITheP's mandate clearly requires an involvement of NITheP staff members in teaching and postgraduate supervision.

Table 13 shows the 2017 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 2017

Node	Undergraduate (hours)	Honours (hours)	Advanced (MSc/PhD) (hours)	Total (hours)
SU	0	92	0	92
UKZN	0	48	0	48
WITS	26	0	0	26
Total	26	140	0	166

Table 14: Postgraduate supervision in 2017 (figures in brackets denote the number of NITheP bursary holders contained in the preceding figure)

Node	Honours (Projects)	MSc	PhD	Total

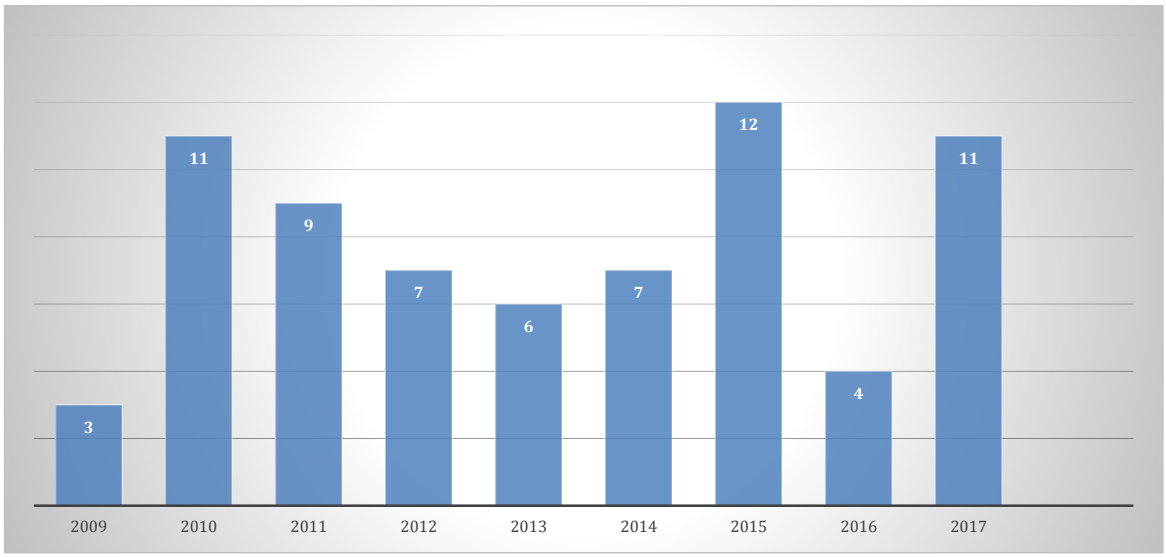
SU	0	2(1)	5(1)	7(2)
UKZN	1	7	8	16
WITS	0	1(1)	3(1)	4(2)
Total	1	10(2)	16(2)	27(4)

The number of MSc and PhD students under NITheP staff supervision who graduated in 2016 is displayed in Table 15.

Table 15: MSc and PhD students under NITheP supervision who graduated in 2017 (figures in brackets denote NITheP bursary holders)

Node	Students	
	MSc	PhD
SU	1	3 (1)
UKZN	3	3
WITS	0	1
Total	4	7(1)

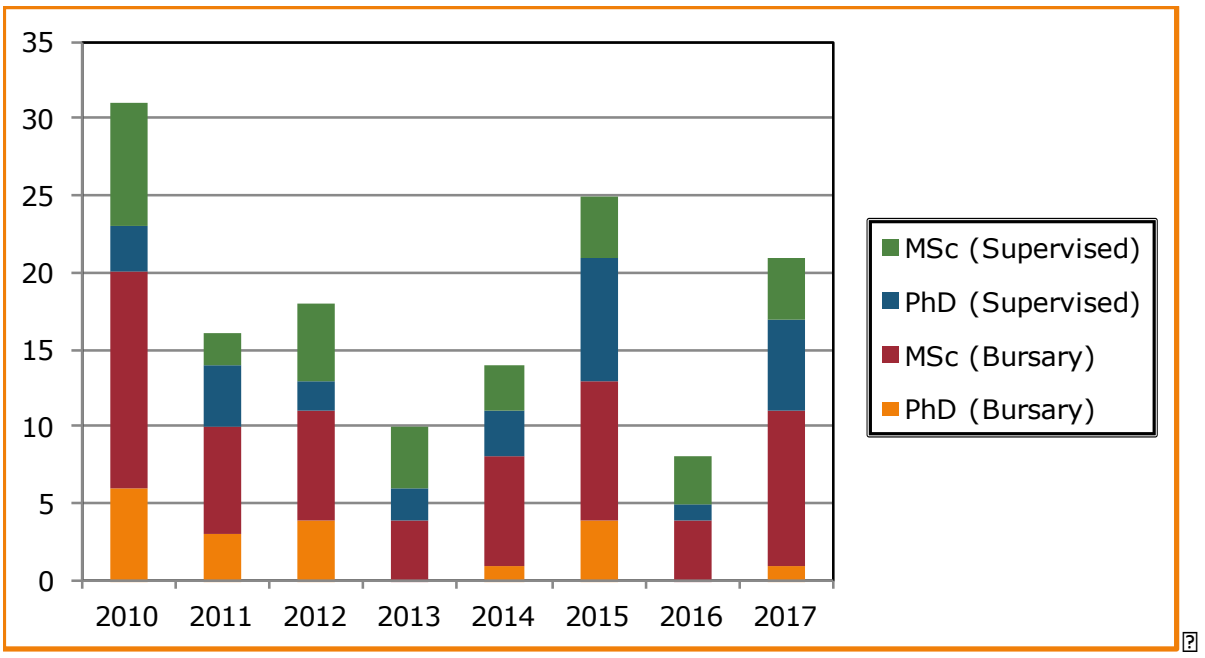
Figure 2: MSc and PhD students under NITheP supervision who graduated in the period 2009 to 2017



The total output of MSc and PhD students who were under NITheP supervision and participated in the bursary programme for the period 2010 to 2017 is shown in
Figure 3.

The decline in the number of graduations over the past 5 years must be correlated with the decline in the number of bursary holders as displayed in figure 1.

Figure 3: MSc and PhD students under NITheP supervision and in NITheP's bursary programme who graduated in the period 2010 to 2017



➢ Publications

The publication outputs are shown in Table 16, while Figure 4 summarises the trend for the period 2007 to 2017.

Figure 5 shows the citation record for the corresponding period and Figure 6 shows the contribution of the core staff and postdoctoral fellows to the total research outputs for the period 2009 to 2017. This shows a decline, indicating a greater contribution from the NITheP network of associates and visitors to the output from NITheP. It also shows that the NITheP model of a national network of researchers is functioning well. The sharp decline as from 2015 does not indicate a lower productivity of NITheP staff or postdoctoral fellows. Their output remained virtually constant, while the output of the network increased considerably as from 2014 due to a larger number of Associates contributing to the publication statistics.

Table 16: Publication output per geographical region for 2017

Geographical region	Publications
Gauteng	31
KwaZulu-Natal	26
Western Cape	27
Total	84

Figure 4: Publication trend for the period 2009 to 2017

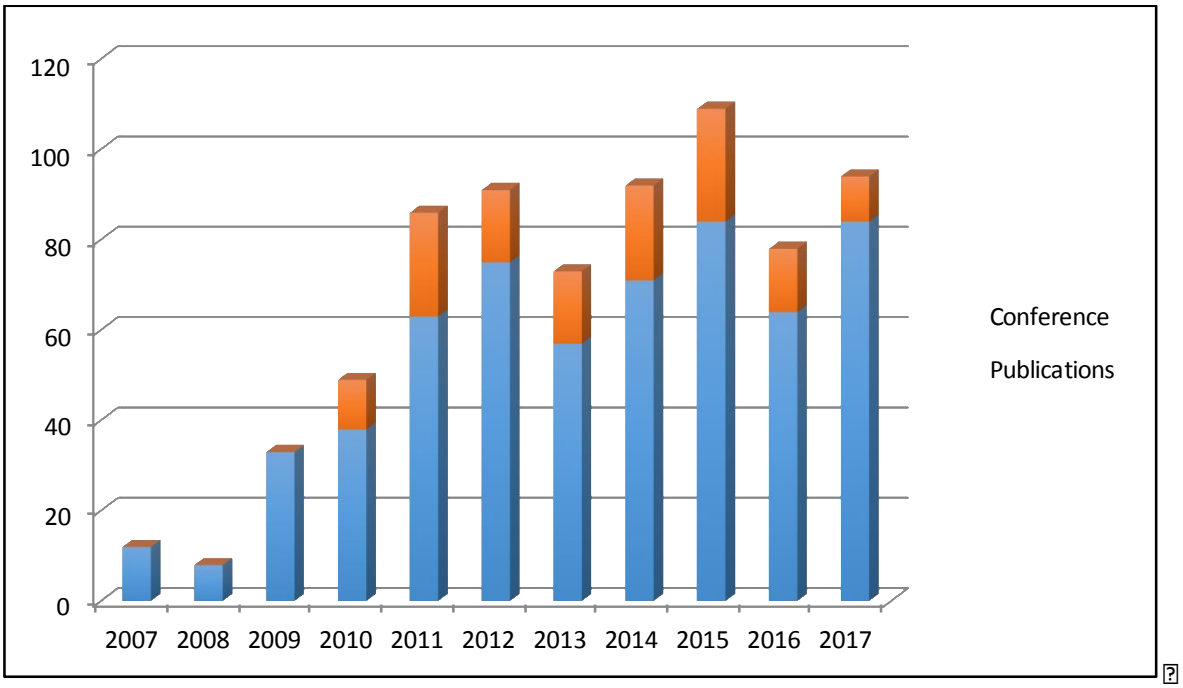


Figure 5: Citation record for the period 2007-2017

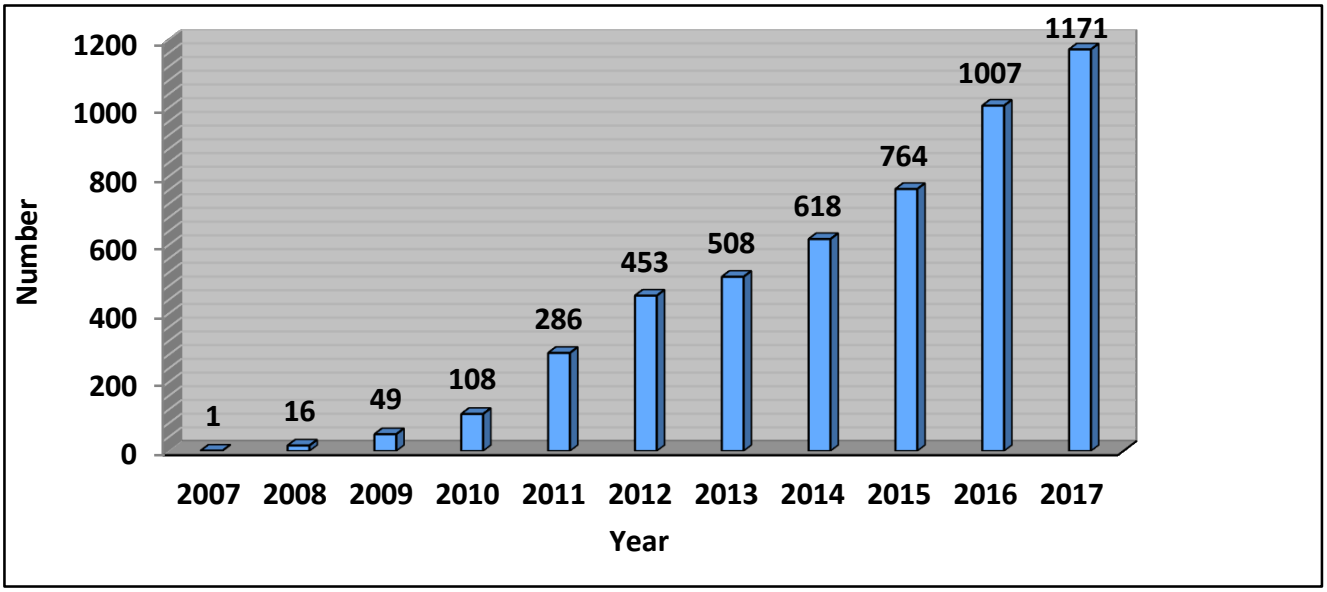
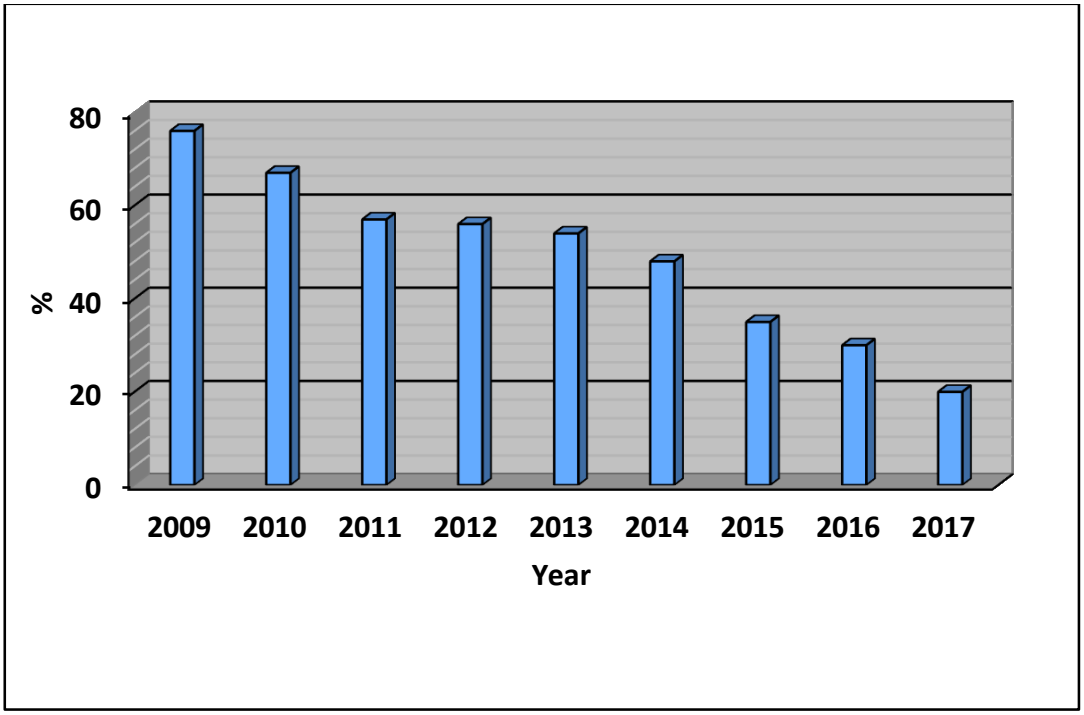


Figure 6: Contribution of core staff and postdoctoral fellows relative to the total number of publications for the period 2009 to 2017



*It is important to note here, that Figure 6 indicates that the contributions from the wider network of Associates is increasingly growing, therefore the downward trend of staff contributions to publications relative to the total publication output.

Nature Index of Leading Institutes in the Physical sciences in Africa for 2017 list shows NITheP as top 10 in Africa.

➢ List of publications containing NITheP affiliation/address

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➢ Conference proceedings

M. Kastner, "Noninvasive measurement of dynamic correlations", Fundamental Aspects of Statistical Physics and Thermodynamics, Bielefeld (Germany), March 2017 (invited talk)

M. Kastner, "Noninvasive measurement of dynamic correlations", Quantum Systems In and Out of Equilibrium, Granada (Spain), June 2017 (invited talk)

M. Kastner, "Noninvasive measurement of dynamic correlations", SigmaPhi, Corfu (Greece), July 2017 (invited talk)

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F. Cinti, “Understanding Quantum Phenomena with Path Integrals: From Chemical Systems to Quantum fluids and Solids”, ICTP, Trieste, Italy – Invited talk. Title: Many-body physics of superfluid filament phases

F Cinti, “SuperFluctuations2017, Fluctuations and Highly Non Linear Phenomena in Superfluids and Superconductors”, San Benedetto del Tronto, Ascoli Piceno, Italy – Invited talk. Title: Classical and quantum filaments of dipolar bosons in free space

F. Cinti, “Workshop on Long-Range Interactions in Atomic Systems” Magnetic dipoles, Rydberg atoms, Ions, USP, São Carlos, Brazil – Invited talk. Title: Many-body physics of superfluid filament phases

FG Scholtz, Scattering in three-dimensional fuzzy space, International Workshop on Quantum Physics: Foundations and Applications, February 2017, UC3M, Madrid.

H. Touchette, “Large deviation simulations: Equilibrium vs nonequilibrium systems Workshop on Numerical Aspects of Nonequilibrium Dynamics”, Institut Henri Poincare, Paris, France

H. Touchette, “Dynamical large deviations of Markov processes Summer School on Fundamental Problems in Statistical Physics”, Bruneck, Italy

H. Touchette, “Large deviations of Markov processes”, ICTS Workshop on Large Deviations in Statistical Physics International Center for Theoretical Sciences, Bangalore, India

H. Touchette, “Conditions for dynamical phase transitions Workshop on Correlations, fluctuations and anomalous transport in systems far from equilibrium”, Weizmann Institute, Rehovot, Israel