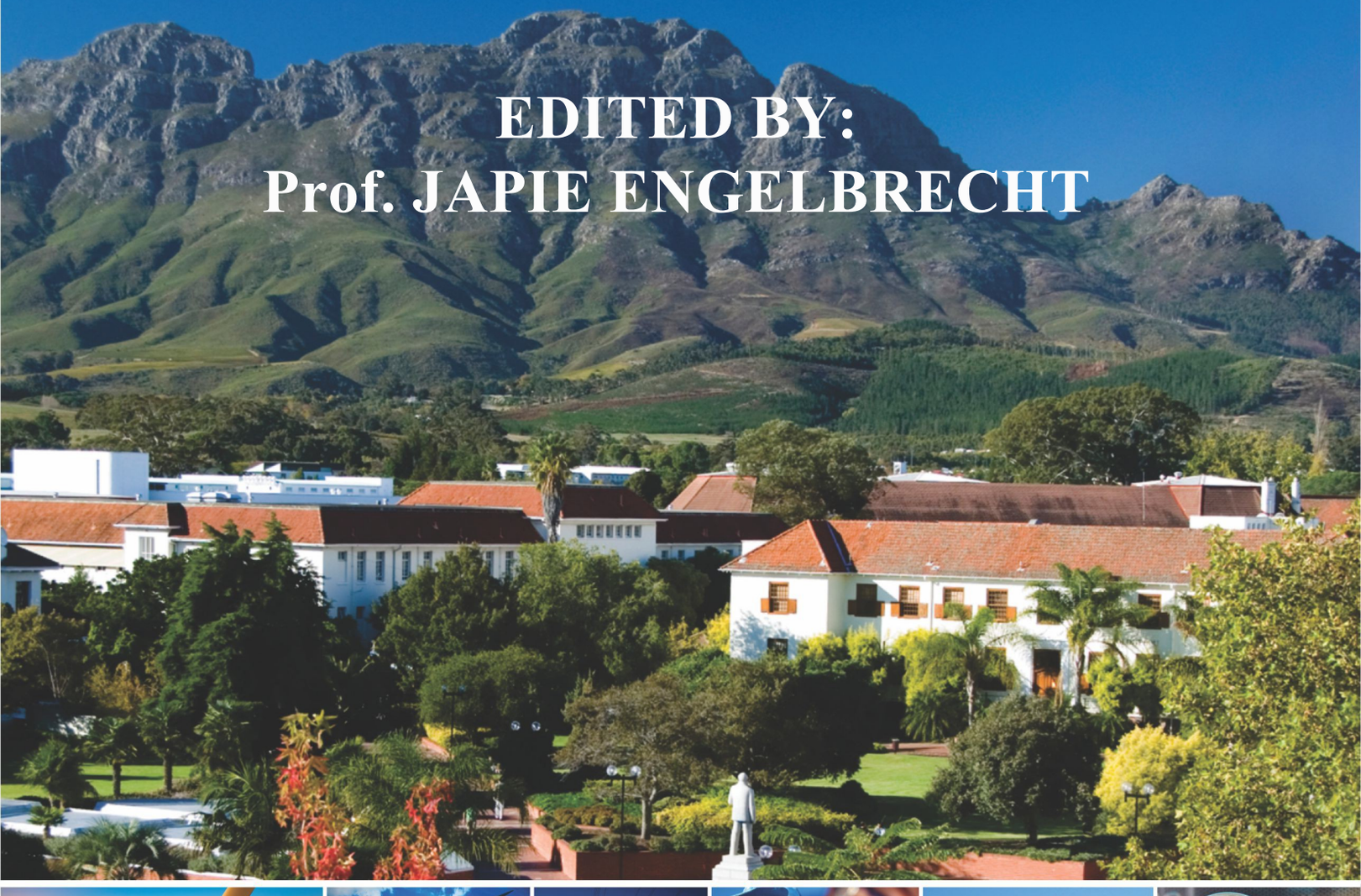
PROCEEDINGS OF SAIP2017

62nd ANNUAL CONFERENCE OF THE SOUTH INSTITUTE OF PHYSICS

EDITED BY:
Prof. JAPIE ENGELBRECHT



WWW.SAIPCONFERENCE.CO.ZA

UNIVERSITEIT STELLENBOSCH UNIVERSITY

1903 2003
FISIKA · STELLENBOSCH · PHYSICS

SOUTH AFRICAN INSTITUTE OF PHYSICS

PROCEEDINGS EDITOR: Prof. Japie Engelbrecht

PUBLISHER: The South African Institute of Physics (SAIP)

COPYRIGHT NOTICE:

Copyright 2018 by the South African Institute of Physics (SAIP)

The Proceedings of SAIP2017, the 62nd Annual Conference of the South African Institute of Physics (SAIP) will only be available electronically on the SAIP website:
www.saip.org.za.

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Abstracting with credit is permitted. To copy otherwise, to republish, to post on servers, or to distribute to lists, requires specific permissions and/or a fee. Request permissions from the SAIP Office,
Tel. +27 (0)12 841 2655 / 2627,
Fax +27 (0)86 648 8474,
E-mail: info@saip.org.za.

ISBN: 978-0-620-82077-6

SAIP2017

Proceedings of SAIP2017,
the 62nd Annual Conference of the South African Institute of Physics

Hosted by the Departments of Physics of Stellenbosch University

3 July to 7 July 2017
Stellenbosch University, Stellenbosch, South Africa

Edited By
Prof. Japie Engelbrecht

TABLE OF CONTENTS

Division F - Applied Physics

Division G - Theoretical and Computational Physics

Conference Chairs and Committees

SAIP2017 Division Chairs

Division for Physics of Condensed Matter and Materials:
Prof. Japie Engelbrecht (Nelson Mandela Metropolitan University)
Division for Nuclear, Particle and Radiation Physics:
Dr. Simon Mullins (iThemba LABS)
Division for Photonics:
Prof. Andrew Forbes (University of the Witwatersrand)
Division for Astrophysics
Dr. Christo Venter (North-West University)
Division for Space Science:
Dr. Du Toit Strauss (North-West University)
Division for Physics Education:
Prof. Sam Ramaila (University of Johannesburg)
Division for Applied Physics:
Prof. Ernest van Dyk (Nelson Mandela Metropolitan University)
Division for Theoretical and Computational Physics:
Prof. Kristian Müller-Nedebock (Stellenbosch University)

SAIP2017 Conference Committee

Prof. Erich Rohwer - Chairperson
Prof. Piet Walters
Dr. Christine Steenkamp
Dr. Pieter Neethling
Prof. Paul Papka
Prof. Kristian Müller-Nedebock
Dr. Hermann Uys
Dr. Richard Newman
Dr. Gurthwin Bosman

Proceedings Editorial Committee

Editor: Prof. Japie Engelbrecht (Nelson Mandela Metropolitan University)
Committee Members: Prof. Deena Naidoo & Dr. John Habarulema
Compilation & Online Publishing: Dr. Roelf Botha & Mr. Juan Grey

Proceedings Review Panel

Prof. Japie Engelbrecht - Editor
Prof. Deena Naidoo - Education and Condensed Matter
Dr. John Habarulema - Astro & Space
Dr. Phil Ferrer - Applied Physics
Dr. Ernest E. Van Dyk - Applied Physics
Dr. Simon Mullins - Nuclear Particle and Radiation
Prof. Simon Connell - Nuclear Particle and Radiation
Prof. Kristian Müller-Nedebock - Theoretical
Dr. Will Horowitz - Theoretical

Message From The Conference Chair

Dear SAIP 2017 delegate,

The physics department at Stellenbosch University would like to extend a hearty welcome to you, in the hope that the conference program will live up to your expectations. We trust that the academic program will be enlightening, and that the social program will be conducive to network-building and making good friends.

The Physics Department at Stellenbosch was founded in 1903 and has a proud tradition of contributing to the South African Institute of Physics and its activities. We have the pleasure of hosting the SAIP annual conference again as we have done successfully in the past. As a physics department we focus on theoretical physics, nuclear physics and photonics. We acknowledge the assistance and contribution of our collaborators from iThemba LABS, the CSIR National Laser Centre and the National Institute for Theoretical Physics to the activities of our department and, particularly, their support for this conference. We thank the plenary speakers who accepted the invitation and have travelled to address the 2017 Annual Conference of the SAIP, and we thank the various sponsors who have made their participation possible. In hosting this conference we embrace the opportunity to facilitate engagement of all the various disciplines in physics participating at the conference. We hope to serve the broader physics community to develop its identity as a professional institute, representing all physicists.

We trust that the workshops will have a positive effect on our younger researchers, and that the plenary presentations will broaden our horizons. Last, but not least, it is our wish that you also enjoy the social activities offered during the week and that you leave Stellenbosch inspired and refreshed.

Prof. EG Rohwer
Head of Physics Department
Chair of the LOC

Message from the Editor

It took me a while to consider the request by Prof Deena Naidoo to become the Editor of the SAIP 2017 Conference Proceedings. However, the more I thought about it, the more it made sense: I am retired, one person will deal with all aspects and will coordinate the process and so on. In my mind's eye I saw delivery of the Proceedings on the expected date, i.e. before the next conference. "After all" (I thought) what could go wrong?" (with apology to the insurance company advertisement on TV).

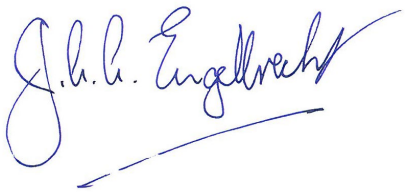
The production of a journal or a proceedings involves a large number of people: the editorial committee, authors submitting articles, two reviewers for each article and finally the editor. If any of the cogs in this "machine" fails, the whole process slows down and is being delayed. Non the less, the review process cannot be hurried along, as eventually the SAIP expects a Proceedings of a standard comparable to that of international journals. We therefore are hugely indebted to the Content Reviewers for their time and due diligence in the review process.

A total of 116 articles were received. Rejection of articles were due to not complying with the required layout, scientific value or not addressing the concerns and suggested corrections of the Reviewers. This was done with the goal of ensuring maintenance of a standard comparable to that of international journals.

I appeal to all students, supervisors and promoters to take much more care in future upon submission of articles to be considered for publication in the Conference Proceedings, to take a greater responsibility in ensuring that articles adhere to the required Layout, and to ensure that articles are proofread before submission to cut down on grammatical and typographical errors. All this will speed up the editorial process, and ensure that the Proceedings can be published timeously.

I wish to SINCERELY thank the following persons for their help and assistance:

- The Editorial Committee under the leadership of Prof Deena Naidoo
- Tebogo Mokhine, whose IT skills carried the day – without him I would have thrown in the towel long ago!
- Mr Brian Masara, CEO of SAIP and John Basco Habarulema, Council member for SAIP Conference matters
- Division Chairs for identifying reviewers, especially those who stepping up to help at the end.
- All content reviewers who participated and who helped to keep the standard of accepted articles of a high standard.
- Dr. Roelf Botha for managing the proceedings compilation and online publishing.



Prof. Japie Engelbrecht
Editor: SAIP 2017 Conference Proceedings

List of Reviewers

Prof.	ABEBE, Amare	North-West University
Dr.	ALBERS, Claudia	University of Witwatersrand
Prof.	ALLIE, Saalih	University of Cape Town
Dr.	ASANTE, Joseph	Tshwane University of Technology
Prof.	ADAMIAK, Daniel	University of Cape Town
Dr.	BARK, Robert	iThemba LABS
Prof.	BASSON, Ilsa	University of South Africa
Prof.	BECK, Geoffrey	University of the Witwatersrand
Dr.	BIETENHOLZ, Michael	Hartebeesthoek Radio Astronomy Observatory
Mr.	BLYTH, S. L.	University of Cape Town
Dr.	BOSMAN, Gurthwin	Stellenbosch University
Prof.	BOTHA, André E.	University of South Africa
Prof.	BOTHA, Johannes R.	Nelson Mandela Metropolitan University
Prof.	BOTTCHER, Markus	North-West University
Prof.	BRAUN, Moritz	University of South Africa
Dr.	BUTHELEZI, Zinhle	iThemba LABS
Dr.	CARLESCHI, Emanuela	University of Johannesburg
Prof.	CHINAKA, Eric	University of Johannesburg (Necsa)
Prof.	CHITHAMBO, Makaiko	Rhodes University
Dr.	CLERK, Douglas	University of the Witwatersrand
Prof.	CLEYMANS, Jean	University of Cape Town
Prof.	COLAFRANCESCO, Sergio	University of the Witwatersrand
Prof.	CONNELL, Simon	University of Johannesburg
Prof.	CORNELL, Alan	University of Witwatersrand
Dr.	CROZIER, Jacqui	Nelson Mandela Metropolitan University
Mr.	DE BEER, Frikkie	South African Nuclear Energy Corporation
Prof.	DE MELLO KOCH, Robert	University of Witwatersrand
Prof.	DEJENE, Francis	University of the Free State
Prof.	DELION, Doru S.	National Institute for Physics and Nuclear Engineering
Prof.	DERRY, Trevor	University of Witwatersrand
Prof.	DHLAMINI, Mokhotjwa S.	University of South Africa
Prof.	DIETEL, Thomas	University of Cape Town
Dr.	DOYLE, Bryan	University of Johannesburg
Dr.	DUNSBY, Peter	University of Cape Town
Mr.	DZHUNUSHALIEV, Vladimir	Kyrgyz-Russian Slavonic University
Mr.	EGGERS, Hans	Stellenbosch University
Prof.	ELLIS, George	University of Cape Town
Prof.	ENGELBRECHT, Christian	University of Johannesburg
Prof.	ENGELBRECHT, Japie	Nelson Mandela Metropolitan University
Prof.	ERASMUS, Rudolph	University of Witwatersrand
Prof.	FAANHOF, Arnaud	North-West University
Prof.	FANG, Yaquan	Institute for Higher Education Policy
Prof.	FERRER, Phil	University of Witwatersrand
Prof.	FISH, Derek	University of Zululand

Prof.	FÖRTSCH, Siegfried	iThemba LABS
Prof.	GEYER, Hendrik	Stellenbosch University
Dr.	GOLDSTEIN, Kevin	University of the Witwatersrand
Prof.	GRAYSON, Diane	University of Pretoria
Prof.	HABARULEMA, John Bosco	South African National Space Agency
Dr.	HARRIS, Richard	University of the Free State
Prof.	HEARNE, Giovanni	University of Johannesburg
Dr.	HERBERT, Mark	University of the Western Cape
Prof.	HOROWITZ, William	University of Cape Town
Mr.	HUSTON, Joey	Michigan State University
Dr.	JANSE VAN VUUREN, Arno	Nelson Mandela Metropolitan University
Prof.	JOHN, Anslyn	Rhodes University
Prof.	JOHN, Ignatius	Cape Peninsula University of Technology
Dr.	JONES, Pete	iThemba LABS
Prof.	JOUBERT, Daniel	University of the Witwatersrand
Prof.	KAR, Deepak	University of the Witwatersrand
Prof.	KARATAGLIDIS, Steven	University of Johannesburg
Mr.	KASTBERG, Anders	Institute of Physics of Nice
Prof.	KEARTLAND, Jonathan	University of the Witwatersrand
Dr.	KNAPPE, Svenja	University of Colorado Boulder
Prof.	KOSCH, Michael	South African National Space Agency
Dr.	KOTZE, Pieter	South African National Space Agency
Prof.	KROON, R. E.	University of the Free State
Prof.	KRÜGER, Tjaart	University of Pretoria
Prof.	LEE, Mike	Nelson Mandela Metropolitan University
Dr.	LEMMER, Miriam	North-West University
Prof.	LEUSCHNER, F. Wilhelm	University of Pretoria
Prof.	LIPPSTREU, Luke	University of Cape Town
Prof.	LINDSAY, Robert	University of the Western Cape
Dr.	MADHUKU, Morgan	iThemba LABS
Prof.	MADJOE, Reggie	University of the Western Cape
Dr.	MALEKA, Peane	iThemba LABS
Prof.	MALHERBE, Johan	University of Pretoria
Dr.	MANOLA, Marco	University of Kwa-Zulu Natal
Dr.	MAPASHA, Edwin	University of Pretoria
Prof.	MAPHANGA, Rapela	Council for Scientific and Industrial Physics
Mr.	MASARA, Brian	South African Institute of Physics
Dr.	MASITENG, Paulus	University of Johannesburg
Dr.	MATTHEWS, Alan	University of Kwa-Zulu Natal
Prof.	MEDVED, Allan Joseph	Rhodes University
Prof.	MEINTJES, Pieter	University of the Free State
Prof.	MELLADO, Bruce	University of the Witwatersrand
Prof.	MEYER, Edson	University of the Free State
Dr.	MEYER, Walter	University of Pretoria
Dr.	MOHANTY, Pankaj	University of Johannesburg
Prof.	MOHR, Peter	Germany Institute for Nuclear Physics
Mr.	MOKHINE, Tebogo	South African Institute of Physics
Dr.	MOLEPO, Mahlaga	University of South Africa
Dr.	MOLOI, Sabata	University of South Africa

Prof.	MOTHUDI, Bakang M.	University of South Africa
Dr.	MSIMANGA, Mandla	Tshwane University of Technology
Prof.	MURONGA, Azwinndini	University of Johannesburg
Prof.	MÜLLER-NEDEBOCK, Kristian	Stellenbosch University
Prof.	NAIDOO, Deena	University of the Witwatersrand
Prof.	NEETHLING, Johannes	Nelson Mandela Metropolitan University
Prof.	NEETHLING, Pieter	Stellenbosch University
Prof.	NEETHLING, Jan	Nelson Mandela Metropolitan University
Prof.	NETSHISAULU, Thomas	University of Limpopo
Prof.	NEWMAN, Richard	Stellenbosch University
Prof.	NGOEPE, Phuti	University of Limpopo
Dr.	NOTHNAGEL, Gabriel	South African Nuclear Energy Corporation
Dr.	NTOAHAE, Peter S.	University of Limpopo
Prof.	NTWAEABORWA, Odireleng	University of the Free State
Dr.	O'CONNEL, Jacques	Nelson Mandela Metropolitan University
Prof.	PAPKA, Paul	Stellenbosch University
Dr.	PELLEGRI, Luna	University of the Witwatersrand
Dr.	PENNY, Clement	University of the Witwatersrand
Dr.	PETERSON, Stephen	University of Cape Town
Dr.	QUANDT, Alex	University of the Witwatersrand
Prof.	RAYNER, Jonathan	University of Sedgefield
Dr.	REDDY, Leelakrishna	University of Johannesburg
Prof.	RICHTER, Werner	Stellenbosch University
Dr.	ROBERTSON, Cherie	University of Johannesburg
Prof.	ROOS, Wiets	University of the Free State
Dr.	RORO, Kittessa	Council for Scientific and Industrial Physics-NLC
Prof.	ROUX, F. Stef	Stellenbosch University
Prof.	SCHOLTZ, Frederik	National Institute for Theoretical Physics
Mr.	SCHULTZ, Ross	Nelson Mandela Metropolitan University
Prof.	SHARPEY-SCHAFER, John F.	University of Western Cape
Prof.	SMITS, Derck	University of Johannesburg
Dr.	SOO KIM, Jong	University of the Witwatersrand (NITheP)
Dr.	STEENKAMP, Christine	University of Stellenbosch
Prof.	STRYDOM, Andre	University of Johannesburg
Prof.	SWART, Hendrik	University of the Free State
Prof.	TAME, Mark	University of Kwa-Zulu Natal
Dr.	TAYLOR, Dale	University of Cape Town
Prof.	TERBLANS, JJ (Koos)	University of the Free State
Dr.	THANTSHA, Nicolas	Tshwane University of Technology
Prof.	THERON, Chris	University of Pretoria
Mrs.	TIBANE, Malebo	University of South Africa
Prof.	TRIAMBAK, Smarajit	University of Western Cape
Dr.	TSHABALALA, K. George	University of the Free State
Dr.	URGESSA, Zelalem N.	Nelson Mandela Metropolitan University
Dr.	USMAN, Iyabo	University of the Witwatersrand
Prof.	VALLABHAPURAPU, Vijaya S.	University of South Africa
Dr.	VAN DER HEYDEN, Kurt	University of Cape Town
Prof.	VAN DYK, Ernest	Nelson Mandela Metropolitan University
Prof.	VAN SOELEN, Brian	University of the Free State

Prof.	VENTER, André	Nelson Mandela Metropolitan University
Dr.	VICKEY, Trevor	University of the Witwatersrand
Dr.	VORSTER, Frederik	Nelson Mandela Metropolitan University
Dr.	WADIASINGH, Zorawar	North-West University
Mr.	WANG, Renjie	CERN
Prof.	WATTERSON, John	University of the Witwatersrand
Prof.	WEIGEL, Herbert	Stellenbosch University
Dr.	WELTMAN, Amanda	University of Cape Town
Dr.	WESTRAADT, Johan	Nelson Mandela Metropolitan University
Ms.	WESTRAADT, Lindsay	Nelson Mandela Metropolitan University (CHRTEM)
Dr.	WHEATON, Spencer	University of Cape Town
Dr.	WIEDEKING, Mathis	iThemba LABS
Prof.	WINKLER, Helmut	University of Johannesburg
Prof.	WYNGAARDT, Shaun	Stellenbosch University
Dr.	YACOOB, Sahal	University of Cape Town
Prof.	ZACHARIAS, Michael	North-West University
Prof.	ZNOJIL, Miloslav	Institute of Nuclear Physics