



Synchrotron Science on the move in South Africa

Sekazi K. Mtingwa

Excitement is growing within South Africa's synchrotron light source user community. That excitement led to a two-day workshop, held December 1-2, 2011, in Pretoria to finalize plans for the drafting of a strategic plan document to be submitted to the government's Department of Science and Technology (DST), which is broadly responsible for science and technology in the country, and the National Research Foundation (NRF), which is responsible for the distribution of research funding similar to what the National Science Foundation does in the United States. Top officials from those agencies attended the workshop, including Romilla Maharaj, NRF Executive Director of Human and Institutional Capacity Development; Rakeshnie Ramoutar, NRF Program Director of Strategic Platforms; and Takalani Nemaungani, DST Director of Global Projects. Daniel Adams, Chief Director: Emerging Research Areas & Infrastructure at the DST provided funding for the workshop and the South African Institute of Physics (SAIP), which is similar to our American Physical Society, handled the logistics.

The entity that mainly drove convening the workshop was the Synchrotron Research Roadmap Implementation Committee (SRRIC), which is co-chaired by Tshepo Ntsoane from the South African Nuclear Energy Corporation (NECSA) and Wolf-Dieter Schubert from the University of the Western Cape.

Approximately forty scientists attended the meeting, including those from international facilities. Herman Winick of SLAC and Sekazi Mtingwa of MIT attended, and Brookhaven National Laboratory's Erik Johnson and Ken Evans-Lutterodt joined via teleconferencing. Johnson and Evans-Lutterodt discussed the pros and cons of South Africa's inheriting Brookhaven's second generation light source called the National Synchrotron Light Source, which is soon to be replaced by NSLS II. However, the consensus of the workshop was that a new third generation facility would much better serve national and regional needs. The largest contingent of foreign visitors were from the various European light sources, including José Baruchel, Jürgen Härtwig, and the Laboratory Director General, Francesco Sette, from the European Synchrotron Radiation Facility (ESRF) in Grenoble, France; Jasper Plaisier from Elettra in Trieste, Italy; Trevor Rayment from Diamond in Oxfordshire, UK; and Hermann Franz from Petra III in Hamburg, Germany. Oxford University's Angus Kirkland did an outstanding job of facilitating the two-day meeting.

South Africa is relatively new to the international community of synchrotron light source users. Simon Connell, of the University of Johannesburg, has documented the history of South African scientists' usage of synchrotron radiation. The first were Trevor Derry and Jacques Pierre Friederich "Friedel" Sellschop (deceased), both from the University of the Witwatersrand (Wits). In 1994, Derry performed studies of diamond surfaces at both the Synchrotron Radiation Source-Daresbury Laboratory and ESRF. During the same year, Sellschop participated in other diamond studies at ESRF. Then in 1996, Giovanni Hearne, currently at the University of Johannesburg, used the facility at ESRF to study materials under extreme pressures. Bryan Doyle, now at the University of Johannesburg, served as a postdoctoral researcher at ESRF around 1999. From those early efforts, the synchrotron light source user community started to grow.

Hearne's early experiences at ESRF so excited him that, upon returning to South Africa, he wrote a two-page letter to Khotso Mokhele, then President of the Foundation for Research Development (now the National Research Foundation), to share those experiences and impress upon him that a synchrotron light source is a key single tool that could have wide impact across many scientific disciplines. Moreover, Hearne suggested that a long-term goal should be for South Africa to construct its own light source via a consortium of international partners, especially involving neighboring countries in Southern Africa.

In 2002, at the urging of the Edward Bouchet-Abdus Salam Institute (EBASI), which is an organization based at the International Centre for Theoretical Physics (ICTP) in Trieste that promotes African – African American collaborations, the African Laser Centre included the design and construction of a synchrotron light source as a long-term goal in its *Strategy and Business Plan*. Next, Tony Joel and Gabriel Nothnagel of NECSA co-authored a motivational paper entitled, *The South African Light Source: Proposal for a Feasibility Study for the Establishment of an African Synchrotron Radiation Facility* (2003), followed by Tony Joel's paper, *The South African Synchrotron Initiative: The South African Light Source: A Synchrotron for Africa - Strategic Plan* (2004). On another front, in 2004, the DST/NRF/SAIP commissioned an international panel of experts that released the report, *Shaping the Future of Physics in South Africa*, which called for consideration of new flagship projects to complement those in astronomy, such as the South African Large Telescope (SALT) and the Square Kilometre Array (SKA). They used a synchrotron light source as a prime example of such a project. Key members of that panel from the U.S. were Ken Evans-Lutterodt, S. James Gates from the University of

Maryland-College Park, and Guebre Tessema from the National Science Foundation.

The first organizational structure for a synchrotron science community took shape in 2003, when a committee of synchrotron users established the South African Synchrotron Initiative (SASI). Van Zyl de Villiers of NECSA played a key role in getting DST's participation in SASI activities. The leadership of SASI mainly consisted of Tony Joel; Simon Connell; Giovanni Hearne; and Lowry Conradie, an accelerator physicist from South Africa's national accelerator center called iThemba LABS, located just outside of Cape Town. As a result of its participation with SASI, in January 2005, the DST itself assumed a leading role in building the synchrotron science community by forming the Synchrotron Task Team (STT), with Tshepo Seekoe of the DST serving as Chair and Simon Connell leading the development of the science case. It was during this period that the synchrotron science community began to mobilize as a coherent group.

With the assistance of SOLEIL, ESRF and other organizations, the STT organized the first two of a series of roughly biennial Science @ Synchrotrons Conferences (S@S) in November 2005 and February 2007. Both conferences were extremely successful in developing new projects and sparking the interest of students in synchrotron light source training. Members of the U.S. physics community, including Herman Winick, Alfred Msezane of Clark Atlanta University, and Sekazi Mtingwa, participated in planning and giving presentations at those conferences, which helped to establish a close partnership between South African synchrotron users and their foreign colleagues, especially the French. After the second conference in 2007, the synchrotron community further empowered itself with the establishment of SRRIC, which succeeded the STT in championing synchrotron science in South Africa. The first Chairs of SRRIC were Simon Connell and Giovanni Hearne. Following the S@S conference in February 2009, Brian Doyle assumed the Chair, followed by Tshepo Ntsoane.

All the above-mentioned activities culminated in the excitement that birthed the December 2011 Strategic Plan Workshop. The NRF representatives requested that SRRIC document the outputs of the workshop by March 2012 in the form of a white paper strategic plan. Then it would study the white paper to determine if it would give the go-ahead for the development of a detailed business plan by June 2012. Those dates were selected to coincide with the dates of the various stages of the government's budgeting process. SRRIC appointed a three-person committee to write the strategic plan, consisting of Brian Masara, Executive Officer of SAIP; Douglas Sanyahumbi, Director of the Technology Transfer Office at the University of the Western Cape; and Sekazi Mtingwa, with the latter chairing the committee.



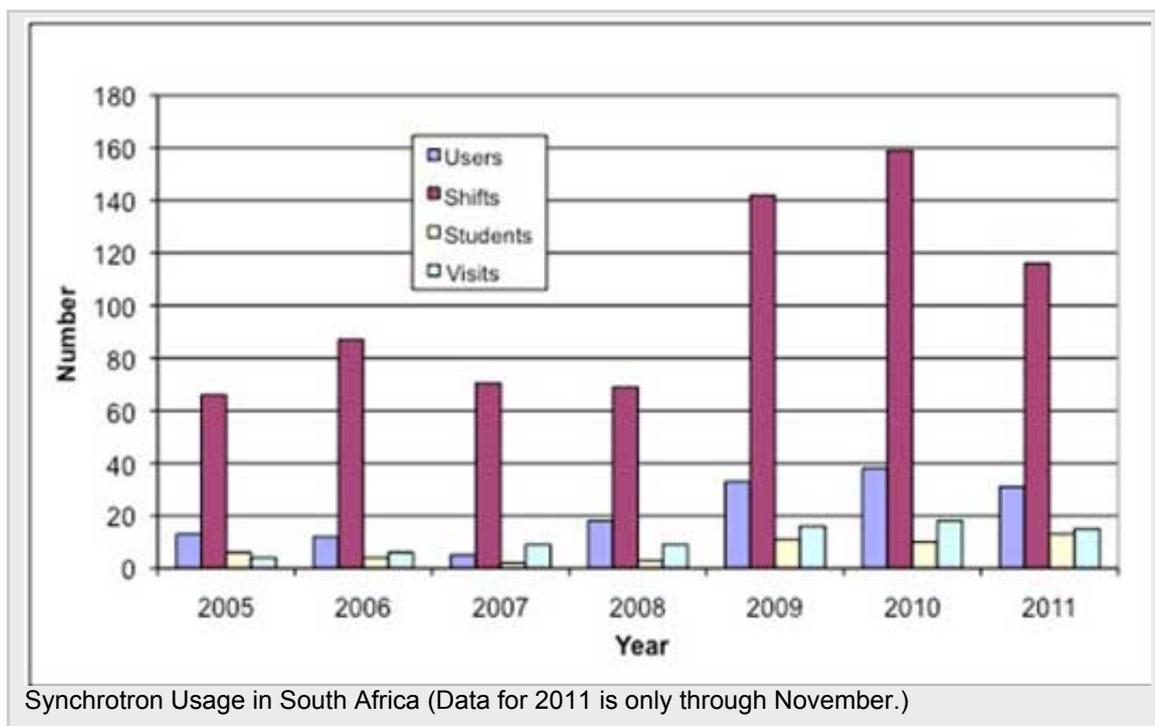
Although the strategic plan has not been completed, there are some overarching comments that can be made. First, there is widespread agreement that the mission of SRRIC going forward will be as follows: To support and facilitate the development and growth of synchrotron science in South Africa in order to ensure that it contributes to excellence in science, innovation and industrial development by exploiting the benefits of synchrotron radiation in advancing fundamental and applied science through

1. Developing human capital, including attracting back the African scientific Diaspora (brain gain) and mitigating any threat of brain drain of young South Africans who have recognized this as a key research tool for their career development;
2. Developing key and/or strategic international collaborations;
3. Ensuring financial support to South Africans whose proposals successfully compete for beam-time at international synchrotron facilities; and
4. Promoting awareness and use of synchrotron science and its capacity to enable the exploration of new frontiers of technology.

In pursuing this mission, the synchrotron science community and the government must undertake a number of key initiatives, including

1. Deciding at what level it should formalize its relationships with foreign light source facilities, especially with ESRF, which is the most heavily used by South African researchers; (Francesco Sette invited South Africa to join ESRF as a Scientific Associate at the 1% level, since its researchers' utilization of that facility is already approximately at that level.)
2. Studying the feasibility of constructing South African or multinational beam-lines at foreign synchrotron facilities;
3. Promoting a significant growth in the number of synchrotron users, with a heavy emphasis on increasing the number of students being trained, such as at the many synchrotron radiation schools that are offered at a number of international facilities and institutions, such as ICTP;
4. Developing programs to preserve and expand the existing technical expertise, such as sending scientists and engineers abroad to join accelerator teams at foreign facilities to expand capabilities in areas such as ultra-high vacuum systems, radiofrequency cavities, magnets, power supplies, and controls;
5. Improving the local, critical feeder infrastructure that allows researchers to prepare and analyze samples before and after being shipped for studies at foreign synchrotron facilities
6. Promoting greater involvement of industrial users;
7. Studying the feasibility for constructing a third generation light source;
8. Developing mechanisms to educate the public about the revolutions in science and technology, such as the discovery of new pharmaceuticals, that synchrotrons afford.

The figure provides a plot of South Africa's synchrotron light source usage in terms of the number of users, beam-line shifts, graduate students trained, and visits to synchrotron facilities. The data represent a rough approximation, based on preliminary surveys; however, note that the 2011 data represent only part of the year, since 2011 had not ended by the time of the workshop. According to the data, the number of students trained at foreign facilities has increased from six (6) in 2005 to thirteen (13) in 2011, thus showing a growth in human capital, especially over the past three years. The long distances and substantial travel expenses are major factors that impede the increase in the number of students being trained. A local facility would be most advantageous to address this need.



Among the workshop presentations, two were especially notable, since they involved applications of synchrotron light source techniques to disciplines for which many are not aware. One involved research in paleontology, for which Kristian Carlson from Wits discussed his collaboration with Lee Berder, also from Wits, and Paul Tafforeau from ESRF. Among

other things, they perform dating and craniodental investigations of the possible human ancestor, *Australopithecus sediba*, which is the much-publicized fossil remains that Berger's nine-year-old son, Matthew, discovered in 2008 while assisting his father in field work. In a presentation involving light source applications to heritage science, Leon "Jake" Jacobson from the McGregor Museum (Kimberly), discussed his applications of light sources to study rock art, namely ancient paintings on stones. He investigates such issues as the composition of the paints and how their interactions with rock substrates contribute to the art's conservation. There is increasing worldwide interest in the use of synchrotron radiation in art and archaeology.

Finally, it is notable that Esna du Plessis and Bruce Anderson attended the workshop to represent the oil and gas company, Sasol Technology. They reported on their use of synchrotron radiation in pursuing extended X-ray absorption fine structure techniques for the study of H₂, CO and synthetic gas activation of nano iron. They also made a strong case for a local source to enable more industrial use of light sources.

In conclusion, the momentum is building rapidly within the South African synchrotron science community. SRRIC, as its representative, is committed to maintaining, and indeed intensifying, that momentum. Based upon the Strategic Plan that summarizes the outputs of the December 2011 workshop, SRRIC is looking forward to a favorable decision from DST/NRF requesting it to proceed to the development of a detailed Business Plan by June 2012 in order to move synchrotron science in South Africa to the next level of international prominence.

Sekazi K. Mtingwa is an accelerator and nuclear physicist at MIT, a founding Board Member of the African Laser Centre, and Senior Physicist Consultant to Brookhaven National Laboratory.

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