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A Rare-Ion facility at iThemba LABS

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iThemba LABS, based around the Separated Sector Cyclotron (SSC), is already the premier nuclear particle accelerator laboratory in Africa and indeed in the Southern Hemisphere. It proposes to address two of the "Grand Challenges" identified by the Dept. of Science & Technology, – i.e. Energy Security and Space Sciences – by building a rare-ion beam facility to bring South Africa to a position of international leadership in the fields of nuclear physics and material sciences.

Internationally, interest in nuclear physics is focusing on the study of the so-called 'terra incognita' – the unknown part of the table of nuclides – which includes the unstable 'neutron-rich' nuclei that cannot be produced using beams of stable atoms. This region holds the key to our understanding of nuclear forces and the origin of the elements of which the Universe is composed. Neutron-rich nuclei can only be created and studied in the laboratory by using beams of artificially produced radioactive-ion beams from an accelerator such as a cyclotron. Because the radioactive-ions in these beams are difficult to produce, and do not occur naturally, they are called "rare-ions". Rare-ions are also of particular use in the development of advanced materials. Measurements of the decay of the probe ion give direct evidence on the site of the implanted ion, on the nature of the site, and on diffusion characteristics of the dopant ions.

iThemba LABS proposes a staged development of a rare-ion beam facility:

1. The first stage would see the addition of a high-current, 70-MeV compact H-minus cyclotron to iThemba LABS. This cyclotron would take over the production of radioisotopes, 24 hours a day, thus releasing the existing SSC to be dedicated to physics research – mainly pure and applied nuclear physics – and to neutron radiotherapy. The capacity for physics training would be more than doubled and the links with international collaborations would be considerably strengthened owing to the increased availability of beam time, currently restricted to weekends only. (Proton therapy is assumed to be transferred to the proposed iThemba Particle Therapy Centre, a private-public partnership which is currently under consideration by the Minister.)
2. The second stage would see the production of radioactive-ion beams, bringing nuclear and materials research and training in South Africa to the international forefront. Since two H–minus ion beams can be extracted simultaneously from the proposed new 70-MeV cyclotron, one of these will be used to produce radioactive ions via the Isotope-Separation-On-Line (ISOL) method. These ions will then be formed into a beam which can then be cooled, mass-analysed, charge-bred and post-accelerated by two of the existing cyclotrons (the SPC1 injector and the SSC) for use in nuclear physics experiments.

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