Status of New Electron Cyclotron Resonance Ion Sources at iThemba LABS

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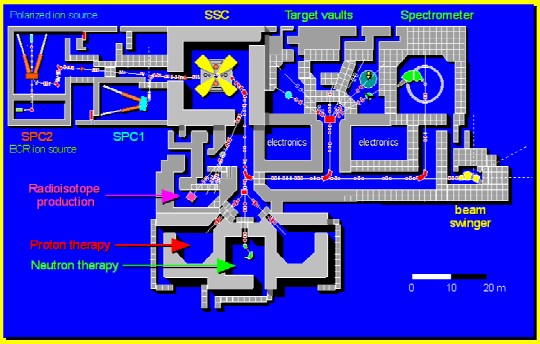
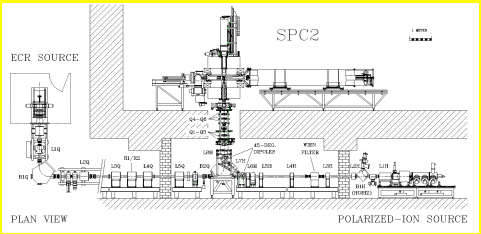
iThemba Laboratory for Accelerator Based Sciences (iThemba LABS) is a multi-disciplinary accelerator facility. One of its main activities is the operation of a separated-sector cyclotron (SSC), which provides beams of various ion species at energies ranging from 5 to 220 MeV/amu. These beams are used for fundamental nuclear physics research in the intermediate energy region, radioisotope production and medical physics applications. During the last 16 years the heavy ion beams at the iThemba LABS were produced in a 10 GHz Minimafios Electron Cyclotron Resonance Ion Source (ECRIS). In 2006 the decision was made that, due to the requirements of nuclear physics for new ion species and higher particle energies, a new 3rd generation ECRIS should be procured. Therefore a source, based on the design of the Grenoble Test Source (GTS), is under construction. It is a room temperature source that uses two microwave frequencies, 14.5 GHz and 18 GHz, to deliver highly-charged ions of sufficient intensity to be accelerated in the separated-sector cyclotron to energies in the GeV range. At the same time a 14.5 GHz ECRIS4 with its beam line elements that was designed and constructed by Grand Accelerator National d'Ions Lourds (GANIL) and originally built for the Hahn-Meitner-Institute (HMI) in Berlin was donated to iThemba LABS and has recentlv been installed.



Layout of iThemba LABS cyclotrons and beam lines



The Q and H beam lines transporting the ions from the Minimafios and polarized proton ion source to the

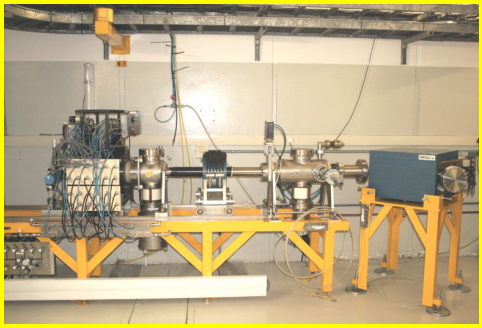
Element	Mass	Energy range (MeV)	
		From	To
H	1	11.5	227
He	4	25	200
B	11	55	60
C	12	58	400
C	13	75	82
N	14	140	400
O	16	73	400
O	18	70	110
Ne	20	110	125
Ne	22	125	125
Al	27	150	349
Si	28	141	141
Cl	37	205	250
Ar	40	280	280
Zn	64	165	280
Kr	84	450	530
Kr	86	396	462
I	127	730	730
Xe	129	750	790
Xe	136	750	750

Beams delivered at iThemba LABS

The Minimafios ECRIS

This source operates at a RF frequency of 10 GHz with an RF power of up to 1 kW. Typical values for the injection and extraction coil currents are around 1000 A at 50 V to obtain a magnetic induction of approximately 0.8 T. The operating pressure varies for different ion species from $1*10^{-6}$ mbar to $1*10^{-5}$ mbar. Some of the results shown in table 2 are obtained with supporting gases like helium or oxygen. The extraction voltage applied to the source varies from 10 to 20 kV. For electron density enhancement a biased disc at -50 V is introduced to the injection side of the plasma chamber. Beam current in eμA (not necessarily optimized for intensity) obtained with the source are up to 800 eμA for H^+, 130 eμA for He^{2+}, 18 eμA for N^{5+}, 16 eμA for O^{6+}, 40 eμA for Ar^{8+}, 4 eμA for Kr^{15+}, and 3 eμA for Xe^{22+}.

The ECRIS4 obtained from the Hahn-Meitner-Institute



This source consists of a water-cooled plasma chamber (length 18cm, diameter 7cm) surrounded by FeNdB permanent magnets which produce a hexapole field of 1T (at the wall of the chamber) for radial plasma confinement. Two solenoid coils produce an axial field which confines the plasma axially. The field on the axis typically varies from 0.4 to 1.1 T. The microwave power is coupled into the source via a wave guide. The generator can deliver up to 2 kW of microwave power at a frequency of 14.5 GHz.

The GTS ECRIS

The source will be coupled to 14 GHz and 18 GHz microwave generators. Provision is made for two ovens. The axial field can be varied between 0.5 T and 1.2 T by means of three solenoid coils and the radial field has a value of 1.3 T using FeNdB permanent magnets. The source is expected to deliver a beam current of 60 eμA Xe^{30+} ions.

	Element	Charge State	Beam Current	Final Energy
Minimafios	**Ar**	**11**	**1.0**	**665**
HMI	**Ar**	**14**	**1.5**	**1078**
GTS	**Ar**	**17**	**4.2**	**1590**
Minimafios	**Xe**	**22**	**3.4**	**825**
HMI	**Xe**	**26**	**5.0**	**1153**
GTS	**Xe**	**37**	**5.4**	**2335**

New beam line layout