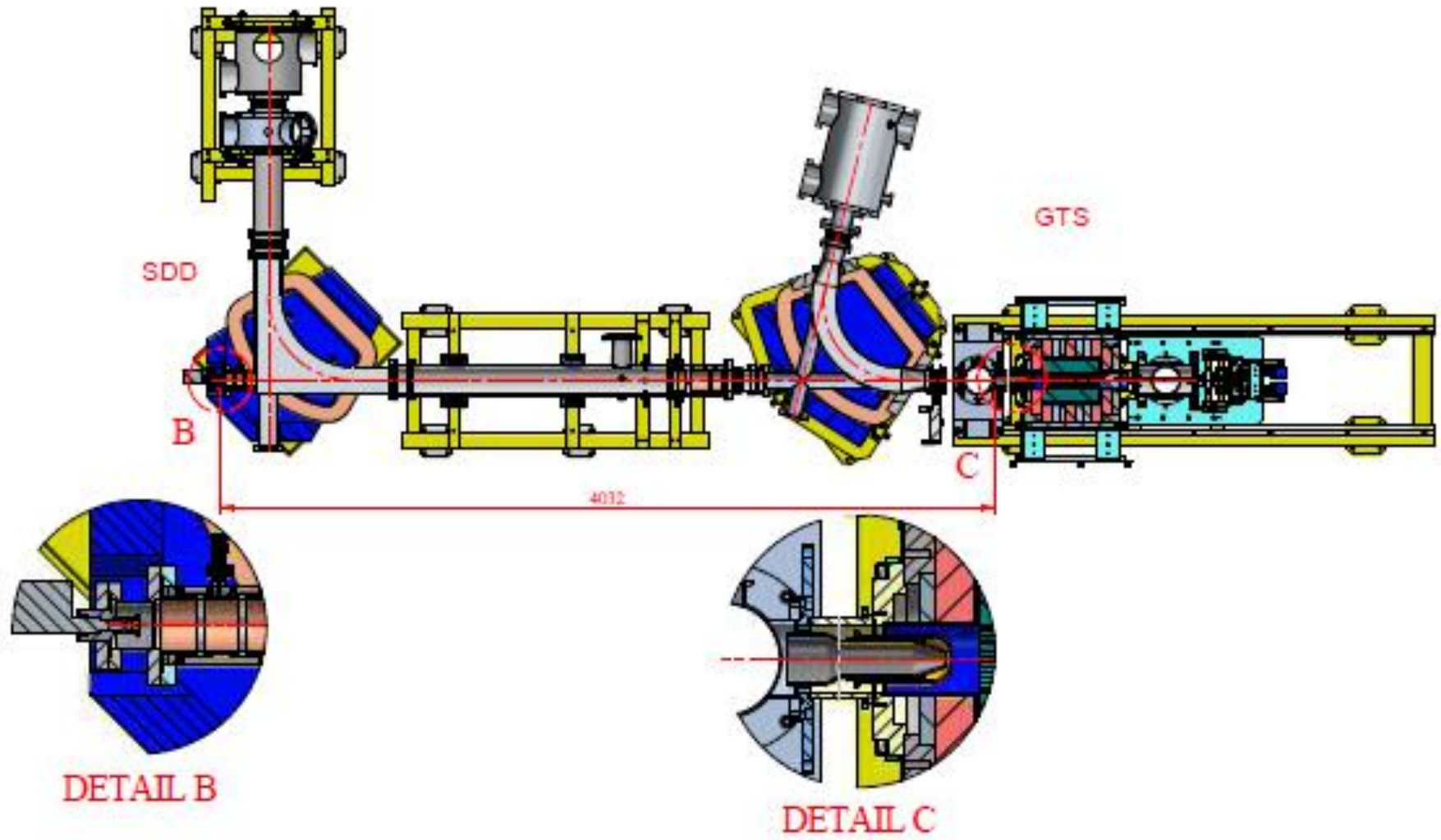
Investigation into the gas mixing effect in ECRIS plasma using Kα diagnostics

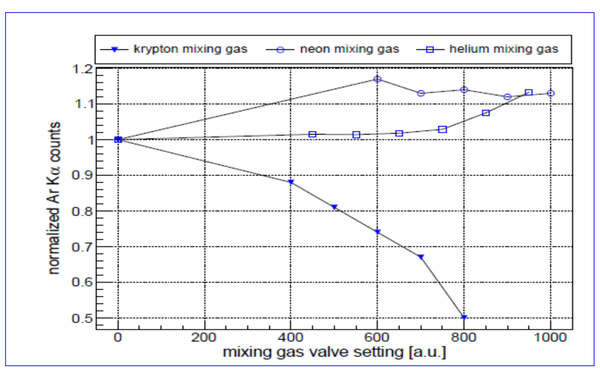
M.Sakildien[1, 3], O.Tarvainen[3], T. Kalvas[3], H. Koivisto[3], R. Kronholm[3], R.Thomae[1], P. Jones[2], J. Mira[1] and F. Nemulodi[1]
[1]Accelerator and Engineering Department, iThemba LABS, P.O. Box 722, Somerset West, 7129, South Africa.
[2]Subatomic Physics Department, iThemba LABS, P.O. Box 722, Somerset West, 7129, South Africa.
[3]Department of Physics, University of Jyväskylä, Jyväskylä 40500, Finland.

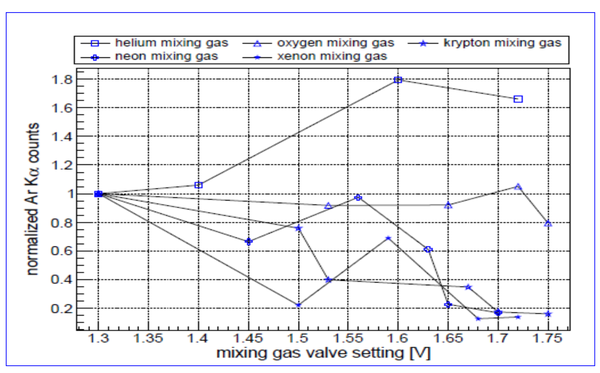
Mixing a lighter gas species into the plasma of an ECRIS is known to enhance high charge state production of the heavier gas species of the ECRIS plasma. With this investigation, Kα diagnostics, optical emission spectroscopy and the measured charge state distribution of the extracted beam were combined to shed more light on the physics governing this phenomenon. Kα diagnostics data from two ion sources, the JYFL 14 GHz ECRIS and the GTS at iThemba LABS, are presented to gain confidence on the observed trends.

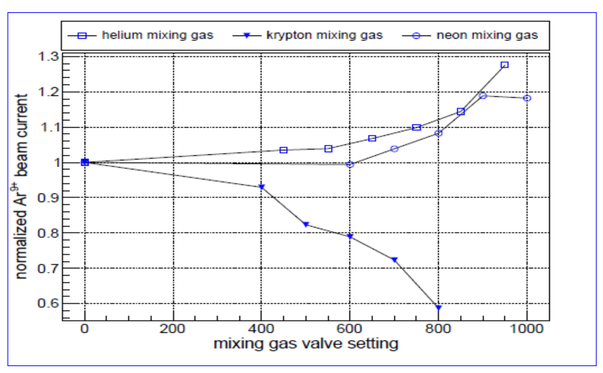


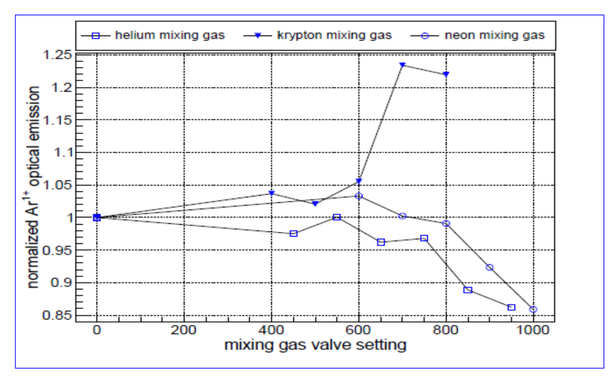
Experimental procedure

In the experiments presented here the flow rate of the working gas (Ar) was kept constant while the flow rate of the mixing gas was varied without optimizing the mixture ratio for any particular charge state. As the response of the pressure gauge strongly depends on the gas composition, and the actual neutral gas pressure in the plasma chamber is unknown due to complex arrangement of the vacuum pumps, the results is presented as a function of the valve setting of the mixing gas. This choice is further supported by the fact that both, the bias disc current and the source drain current, were not observed to follow the gas flow rate monotonically which invalidates them from being a measure of the neutral gas pressure.









Main result and discussion

- Both sources (GTS at iThemba LABS and 14 GHz ECRIS at JYFL) show similar trends
- <σv> is proportional to electron density, ion denmsity and the rate coefficient for ionization
- Inner shell ionization rate increase with lighter mixing gas
- Inner shell ionization decrease with heavier mixing gas
- Diagnostics of the lighter gas reveals more about the physics of the gas mixing
- Normalized Ar^{1+} optical emission displays different behaviour depending on the mixing gas used
- Ar^{9+} shows opposing trends to the normalized Ar^{1+} optical emission
- Current investigation and results appear to favour ion cooling as the mechanism responsible for the effectiveness of the gas mixing

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