HEAVY-ION RFQ ACCELERATOR MAXILAC ACHIEVES 45 keV/AMU

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In 1985 the heavy-ion RFQ accelerator MAXILAC, designed for the acceleration of ions of A/q up to 130 (Xe^+, U^{2+}, ...), has been completed to 3 modules (May 1985, 20 keV/amu) and finally to 5 modules (October 1985, 45 keV/amu). The completion was made stepwise because there is no beam diagnostics inside the structure indicating beam losses; if the transmission would be poor, it would have been impossible to see where the beam has been lost.

The four coupling manoeuvres have been carried out with no major difficulties. The mechanical concept has been proven to be sound. Alignment and longitudinal adjustment of the structure have been perfect. After short periods of multipactoring, the r.f. voltage came up very stable and flat (unflatness < 10 % between both ends). The power consumption to build up a given voltage level is less than expected, R_p is close to the ideal value with virtually no losses by contacts and surface roughness. So Kr^+ could be accelerated with 3 modules, and U^{4+} with 5 modules using the old 80 kW amplifier even with reserves for strong beam load.

The new power amplifier, with tube RS2042, made good progress. The inner RF compartment is complete with all RF circuits, including the RS2024 driver. The outer compartment and the power supplies have been delivered in December. The power of the amplifier will be sufficient to drive the 26 m long structure which is planned to become the 130 keV/amu UNILAC/SIS injector, and of which the present MAXILAC contains five out of 12 modules.

The beam transmission figures of module 1 have been given in the 1984 annual report[1]. With three modules, the transmission has been 60 %, for Kr^+ the maximum beam current has been 8 mA. Time was not sufficient to improve this figure, because the transmission depends very sensitively on the source conditions and on matching. Source noise is to be minimized by aging procedures including permanent careful readjustments of all parameters. Calorimeter measurements at the RFQ output have shown that the average ion energy is correct.

In the last runs before shut-down in October, efforts have been undertaken to extend the versatility of the facility. MEVVA, a metal spark ion source developped at Berkeley, was installed to produce uranium beams, in place of the CORDIS source used so far. 4mA-U^{4+} and 5mA-U^{3+} beams could be measured at the RFQ output after a few days. The pulse rate was limited to 1 s^{-1}, effective pulse width 50 µs. Experiments with longer pulses (new spark supply) were unsuccessful because the beam spent by the injector was too noisy.

With five modules, MAXILAC accelerated so far U^{4+} ions only, maximum beam current of 2 mA. Maximum beam transmission now is at a slightly higher RF voltage required for sufficient bucket size in the fifth module where ϕ_s approaches -30°, and with this voltage some matching difficulties still exist at the entrance. The solution will be an improved shape of the transverse matching section which is being manufactured.

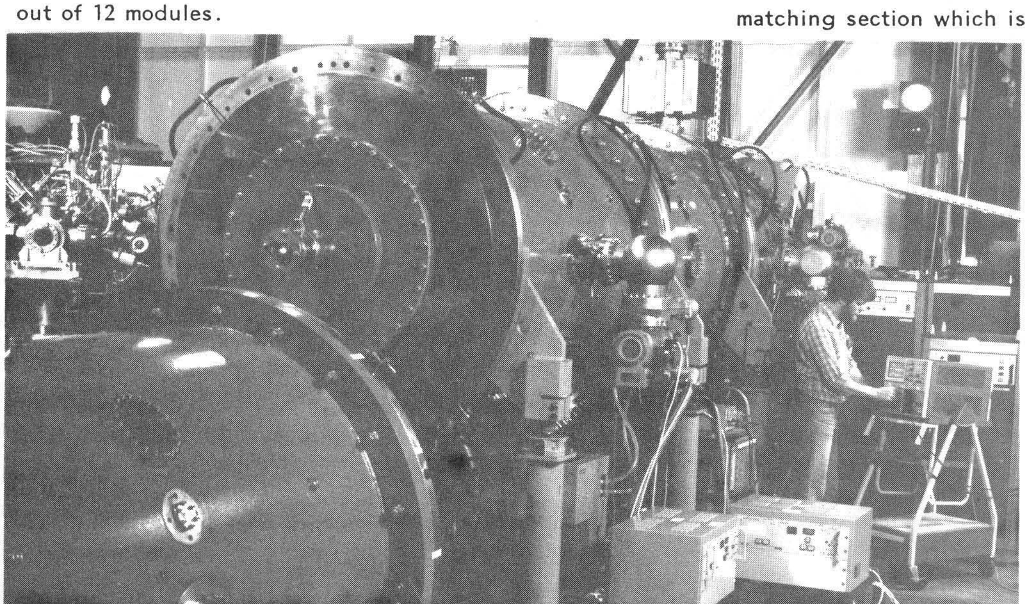

Fig. 1
MAXILAC with 3 modules. A Ta foil behind a glass window is seen glowing at the beam exit. Though the duty cycle is 1 %, the 10 kW beam power produce an average power of 100 W.

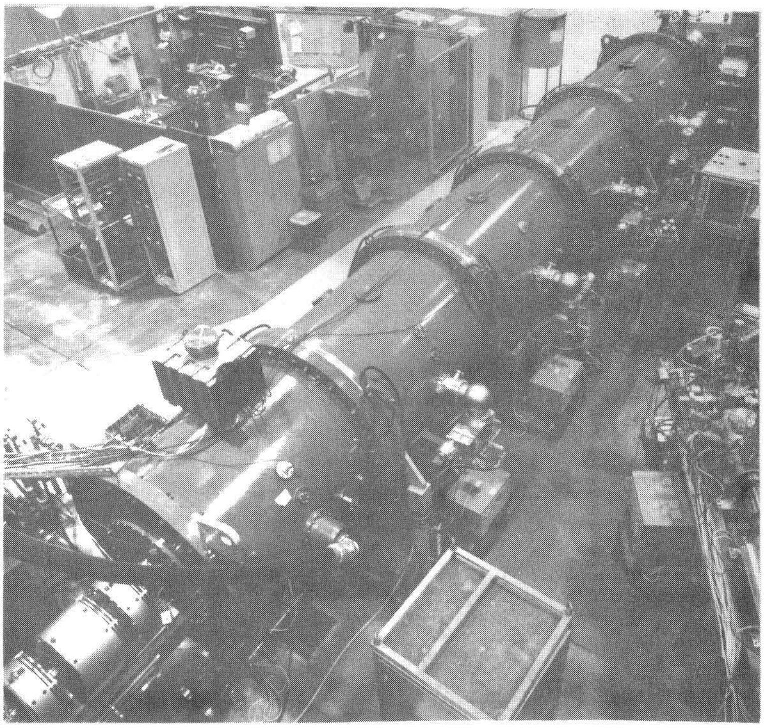

Fig. 2. Complete five-module accelerator with an analyzer beam line.

Target experiments are being prepared. The first one will look for excimer excitation. For this purpose the beam must be focused onto a small spot of down to 1 mm^2. An electrostatic quadrupole multiplet has been calculated which promises the required properties.

Fig. 2 shows the five-module accelerator completed by an analyzer beam line. In January 1986, again a CORDIS type ion source has been installed into the injector, delivering an Ar$^+$ beam. Work on adjustment and matching of this beam into the RFQ is still continuing.
With an output beam intensity of 3mA, the beam has been analyzed by the magnetic analyzer setup. The result is shown in figs. 3A-C. The behaviour is as expected and typical for an RFQ accelerator. The particle energy at the bucket centres is determined by the $\beta\lambda$ profile of the machine only, whilst the details of the spectra, the optics, and the transmission depend on the RF amplitude.

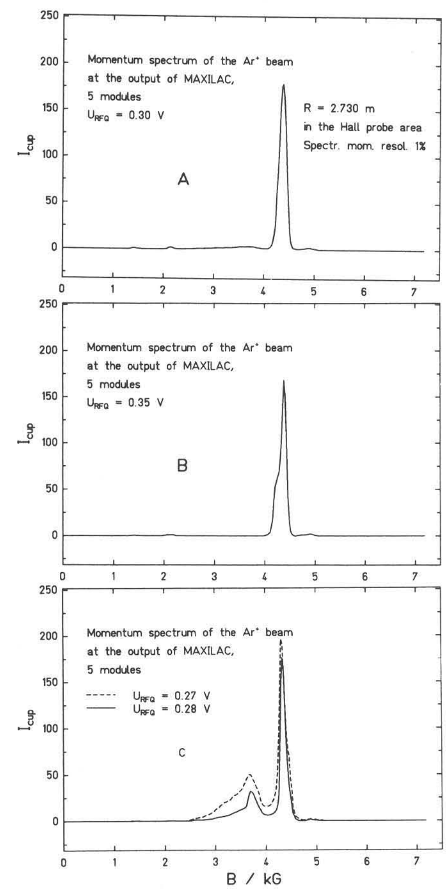

Fig. 3. Beam momentum spectra. The RF voltage has been adjusted to the optimum transmission (fig. 3A, top). A clean spectrum is seen with the peak at exactly 45 keV/amu. In the rest gas of the beam line, 10^{-6} hPa over 2 m, a small portion of the beam is stripped into Ar^{2+} and Ar^{3+}. Fig. 3B (centre) and 3C (bottom) show the spectra at a higher and a lower RF amplitude, respectively. In the latter case the bucket is too small, particles are being lost. The peak, however, remains at 45 keV/amu.

To write the spectra (cup current behind a 2 mm slit) the deflection magnet field is varied. The lens settings remain fixed, tuned for the peak.

Reference:

1. R.W. Müller, J. Bolle, P. Spädtke, U. Kopf, GSI 85-1, p.361.

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