UNILAC Machine Experiments in 2012

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In the UNILAC machine experiments 2012 investigations on carbon foils and methane and hydrogen gas for stripping in future UNILAC scenarios have been performed as well as optimisations of the UNILAC.

Stripping experiments

Thin carbon foils from the GSI target laboratory (20 resp. 30 µg/cm^2) have been tested in March in the experimental areas at TASCA (X8) and SHIP (Y7) on rotating target wheels. At X8 a low current Au^{25+} beam (4 eµA, 3.6 MeV/u, 3 ms, 50 Hz) has been applied 24 hours on 4 foils, at Y7 a U^{28+} beam (2.5 emA, 3.6 MeV/u, 100µs, 2 Hz) has been applied to 8 foils 48 hours. While the long beam pulses at X8 were evenly distributed on the moving foils (by 5 cm) [Fig. 1], the beam spot of the short 100 µs pulses at Y7 was scanned over the foil by the rotary motion of the wheel by shifting the phase of the target wheel. In both setups the foils showed typical characteristics of the irradiation, without any damages.

Fig. 1: TASCA target wheel after irradiation.

In November a set of thin carbon foils has been tested with a 5 emA U^{4+} beam at 1.4 MeV/u (100 µs, 2 Hz). Ten standard carbon foils (20 µg/cm^2), all from the same material but prepared under different conditions, mounted on a fixed carrier, have been irradiated approximately four hours each. Although some of them seemed to be unharmed after irradiation (camera in the stripping chamber), only two were actually undamaged after venting and dismantling from the vacuum chamber [Fig. 2]. This confirms the experiments from October 2011, when similar foils had been damaged after irradiation with comparable dissipated energies (about 4 kWs/cm^2) [Fig. 3]. Emittance measurements behind the stripper showed no significant variation during irradiation. The energy loss through the foils was typically 24 keV/u at the beginning and 22 keV/u after irradiation. Two foils from an external provider have been tested too, but broke within few pulses of beam. Further carbon foils were irradiated in the M-Branch for materials research investigations.

Fig. 2: Carbon foils after irradiation (5 emA U^{4+}, 1.4 MeV/u).

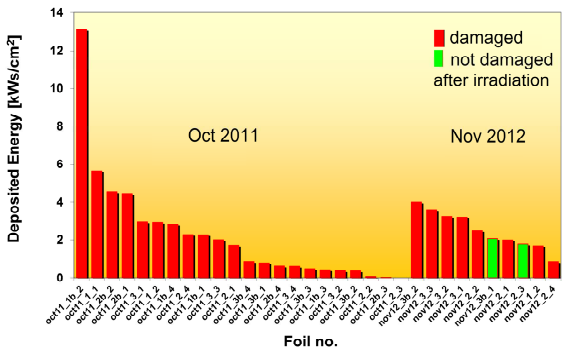

Fig. 3: Statistics of the irradiated foils (20 µg/cm^2).

In addition experiments with methane and hydrogen as stripping gas in the existing UNILAC gas stripper were performed (high current U^{4+}, 1.4 MeV/u). Charge state spectra, beam currents, and emittances behind the stripper were measured for various methane flow rates [1].

UNILAC Optimisations

Investigations of the HSI transmission showed that the small aperture of the quadrupole quartet in front of the RFQ restricts the matching, therefore the ongoing upgrade of the quartet (larger aperture) is essential. Beam attenuation by increasing instead of reducing the field strength in the quartet was proved, so the power supplies for the new quartet do not need to cover the full current range below the light-ion operation (5% of max. filed) down to zero with high accuracy.

To provide heavy ions with higher charge states than e.g. U^{73+} for the SIS, thicker stripping foils in the transfer channel (11.4 MeV/u) were tested (1000 µg/cm^2). The spectra revealed a slight increase of the U^{74+} charge state, but a worse separation.

Additionally the beam diagnostics department performed tests of a prototype signal processor for position and phase measurement, the bunch shape monitor in the transfer channel, SEM grids, scintillator targets, and fluorescent screens.

References

[1] B. Schlitt, "Beam Measurements CH4 and H-gas strippers", (this report).