High Intensity TASCA Target Wheel Control System and Target Monitoring

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The gas-filled recoil separator TASCA [1], optimized for actinide-target based hot fusion reactions, was recently used for studies of superheavy elements with Z = 115,117 and for the search for new elements [3,4]. These experiments require transuranium targets made from isotopes that are produced in high-flux nuclear reactors and are available only in very limited amounts [5-7]. At the GSI Darmstadt, the UNILAC provides intense beams, delivered with a 25% duty cycle (5 ms pulse length, 50 Hz repetition rate). Due to small cross sections for the production of the heaviest elements, maximum beam intensities are applied, which in turn put a large heat load onto the target.

At TASCA, a new target wheel has recently been developed [8], which was optimized for maximum applicable beam intensities, respecting the available amounts of target material, the desired areal density of 0.5 mg/cm^2, the maximum permissible beam spot size of 8 mm diameter, and the beam macrostructure. This new target wheel rotates at 2250 rpm and consists of four individual target segments with 6 cm^2 area each, necessitating about 12 mg of target material (Figure 1). Each beam pulse illuminates one single target, which subsequently cools during 75 ms before being hit by the next pulse. The target wheel is placed inside a target cassette. Upstream of the target wheel, a second wheel can be mounted, e.g., containing carbon stripper foils to increase the charge state of the beam.

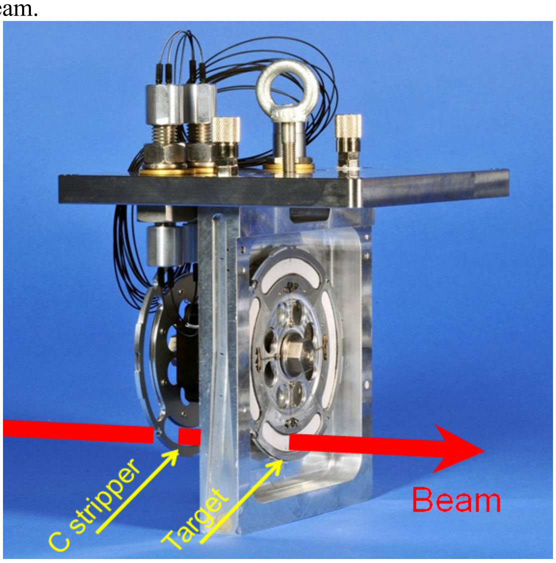

Figure 1. Photograph of the new TASCA target wheel.

The wheels are driven by a stepper motor (Nanotec). The wheel position control is provided by a microcontroller SPS and an industrial PC, which use signals from 2 photodiodes outside the target chamber connected to the target cassette through light fibers. This allows synchronizing the wheel rotation with the beam macrostructure such that each individual macro pulse illuminates a single target segment.

To insure target integrity, several on-line as well as off-line monitoring possibilities are exploited. The on-line control is a part of the "TASCA Control System" (Figure 2) and is based on a beam current measurement and a contact-free temperature measurement of the beam-spot area with a pyrometer. Upon violation of user-defined thresholds, or asynchronous rotation, the beam is switched off within 1 µs. Off-line capabilities include the monitoring of the target and the carbon stripper foil wheel with two endoscopes, which allows obtaining sets of 36 pictures covering all four segments. If the target isotope has a significant α branch, the α particles can be guided to the focal plane detector in TASCA, where the rate of incoming α particles and the energy spectra yield information on the target thickness and status of the layer.

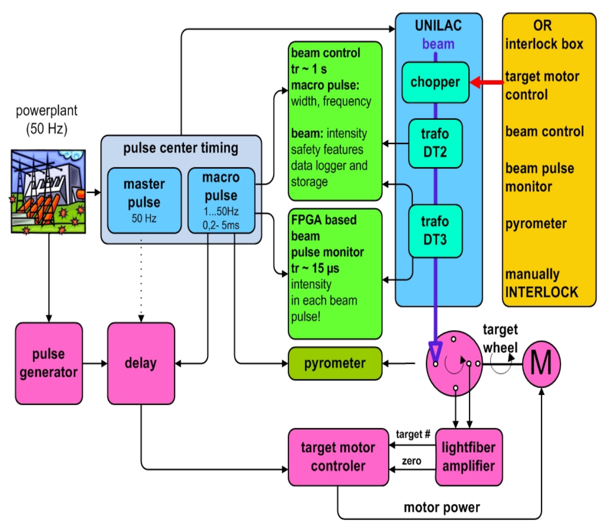

Figure 2. Scheme of on-line target monitoring system.

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