Light output of inorganic scintillating screens induced by fast and slow extracted beams from SIS18*

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Scintillating Screens are favoured devices to visualize the transverse beam profile during alignment and are foreseen for the HEBT at FAIR. For high energy ion beams extracted from SIS18 tests on the reproducibility of the scintillation process for different materials were performed to enable a proper choice for FAIR. Moreover, emission spectra were investigated as reported in [1].

Radiation hardness tests were carried out as well. The results concerning ceramic targets in comparison to measurements at UNILAC are summarized in [2].

Experimental Conditions

The investigations were performed with beams of protons, Nitrogen, Nickel, Xenon and Uranium as extracted from SIS18 with 300 MeV/u beam energy and intensities between 10^6 and 10^{10} particles per pulse. At the target location HTP seven different scintillating screens were irradiated in air (P43, P46, YAG:Ce, Chromium-doped and pure Aluminium Oxide). The measurements were performed in slow (300-400 ms) and fast extraction (1 µs) mode to analyze supposed saturation effects.

The scintillation light was recorded by a monochrome camera equipped with a remote-controlled iris and an optical grey filter (transmission ~5 %) to increase the measurement range.

Images with beam induced scintillation profile as well as background images were analyzed by a dedicated Python script to calculate light output (in particular sum of luminescent area) and beam profile characteristics as given by statistical moments. Moreover, a relative light yield was calculated as the light output per ion normalized to the deposited energy. This factor is used to compare the light emission from the targets with respect to the irradiation by different ion species.

Results

For all investigated ions, linearity between the light output with respect to the number of particles per pulse was observed for fast as well as for slow extraction, see Figure 1 exemplary for P43. Statistical moments were analysed in order to investigate changes of the beam reproduction during irradiation. Also the projected beam sizes were found to be independent from the amount of irradiating particles per pulse for each material, apart from variations by operative re-alignment.

The light yields of P43 phosphor for various projectiles relative to the protons light yield are shown in Table 1. A decrease as function of atomic number is clearly observable and the results show a different reaction on the impact of slow and fast extracted beam on the P43 screen. Generally, the light yield varies only by a factor 3 between light and heavy ions. The analysis for other targets is on-going.

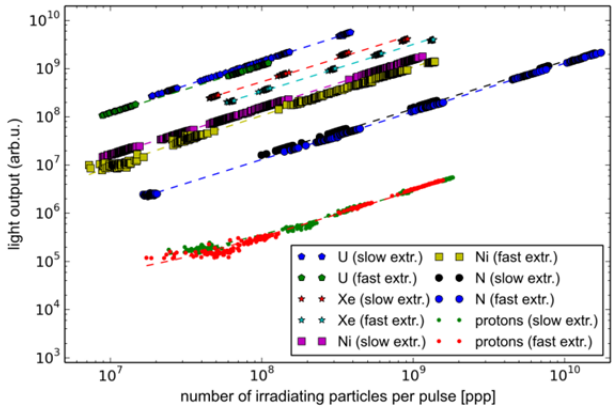

Figure 1: Light output of P43 phosphor screen induced by different ions. All projectiles were accelerated to 300 MeV/u and extracted in fast (1 µs) and slow mode (300-400 ms).

Table 1: Relative light yield of P43 phosphor screen for different projectiles. Proton induced light yield serves as reference. The beam energy at the target is given in brackets. In general ions were fully stripped at the target.

Projectile	Relative Light Yield (slow extr.)	Relative Light Yield (fast extr.)
p	1.00 (299 MeV/u)	1.00 (299 MeV/u)
N	0.97 (297 MeV/u)	0.85 (299 MeV/u)
Ni	0.66 (289 MeV/u)	0.44 (297 MeV/u)
Xe	0.56 (281 MeV/u)	0.34 (294 MeV/u)

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References

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