Proton Induced Thermal Stress-Wave Measurements for ISOLDE and CNGS using a Laser Doppler Vibrometer

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Radioactive ion beams (RIB) and neutrino beams are generated by the nuclear interaction of a proton beam in a target. The production of high secondary particle intensities require high-power primary proton beams, which cause stress formations up to the fatigue limit or even up to the structural strength of solid targets.

Thermal stress-waves are generated in the solid target material when the proton beam interacts. These stress waves excite natural oscillations of the target or cause plastic deformations. Hence, an experimental setup with a laser Doppler vibrometer [1] was developed to investigate free surface vibrations of cylindrical targets. The target configurations for RIB and conventional neutrino beams (CNGS project) were investigated to analyze proton induced thermal stress-wave generation and propagation.

The chosen measurement device allowed to measure individually the immediate response after proton impact for the first time. Additionally, the transient state and the following natural vibrations of the eigenmodes with its decay behavior were analyzed. Surface displacement amplitudes in the sub-micrometer range could be recorded at distances of up to 40 m without any contact between the target and the sensor.

In the following, the laser Doppler vibrometer and the experimental setups are described and the advantages compared to conventional methods are given. The measured characteristic free surface velocity and displacement signals for cylindrical targets irradiated with a proton beam parallel to their axis are discussed.

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References

[1] POLYTEC® Webpage. POLYTEC GmbH, Polytec-Platz 1-7, D-76337 Waldbronn, Germany, http://www.polytec.com/, July 2005.