

Laser Beam Position Stabilization for Beam Instrumentation at the Spallation Neutron Source

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Particle accelerators are instrumental tools for scientific research. The hydrogen ion accelerator at Oak Ridge National Laboratory's Spallation Neutron Source (SNS) provides the world's most powerful proton pulses for generating neutrons. One method for ion beam profile measurement is based on lasers, which provide non-invasive profile measurements of the particle beam in the superconducting linear accelerator portion of the SNS. The primary challenge of using this method is maintaining the laser beam's stability. The laser beam propagates over a long distance through free space and suffers from position drifts caused by mechanical vibrations and temperature variations. A position stabilization method was developed using a LabVIEW-based program, an analog position-sensitive detector, and a motor-driven mirror capable of providing position corrections synchronized to the laser and ion pulses. This laser-beam stabilization method has the advantages of a fast reaction time and a high tolerance to radiation; the previous digital camera-based system degraded quickly in the high-radiation environment of the accelerator. The successful implementation of this method will provide improvements in laser-based beam instruments in high-power particle accelerator facilities.