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## Jet and Extended Gas Target System for the Felsenkeller Underground Laboratory

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We present a newly developed jet and extended windowless gas target system, tailored to meet the precision measurement demands of modern nuclear astrophysics. Our system can be operated either in jet or extended modes without necessitating modifications in pumping power. Real-time monitoring of a jet, facilitated by laser interferometry techniques, ensures control of target parameters during operation. Our development process involved comprehensive computational fluid dynamics simulations to optimize nozzle geometry. Characterization of the jet target involved both absolute target thickness determination using alpha energy loss techniques and relative thickness measurements via laser interferometry. These techniques collectively ensure a comprehensive understanding and control of target parameters. Experimentally measured the areal density of the jet on the order of  $10^{18}$  atoms/cm<sup>2</sup>.

For the extended gas target setup, pressure, and temperature profiles are measured to construct the density profile of an extended gas target. Additionally, a beam calorimeter has been developed and tested to measure the beam intensity.

The setup has undergone development and testing at the Rossendorf Center and now is in the commissioning phase at the Felsenkeller underground ion accelerator laboratory. Our report will provide insight into the developments, characterization, and operational capabilities of our newly developed combined gas target system.

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