Jet Experiments in Nuclear Structure and Astrophysics (JENSA) gas jet target commissioned for use with FRIB beams

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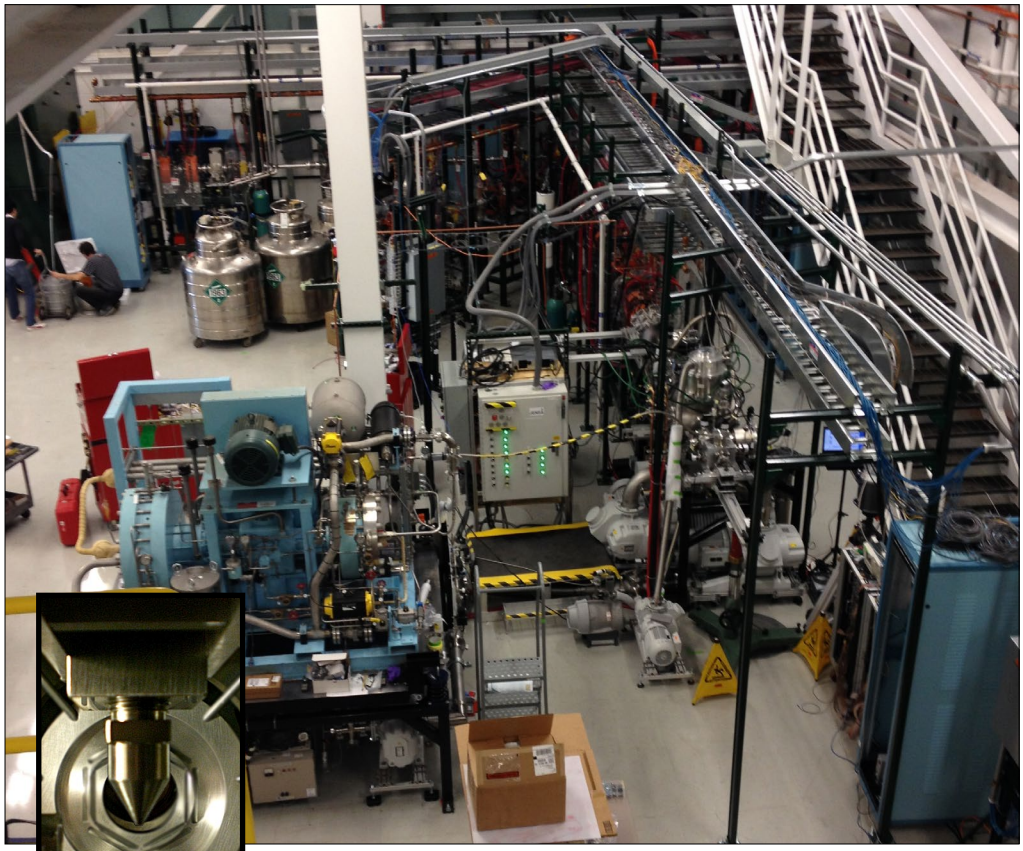
Scattering and transfer reaction measurements involving light nuclei, such as those common in nuclear astrophysics and structure experiments, require targets that are spatially localized so that the angular distribution of reaction products can be measured. These experiments, along with direct-capture measurements, also benefit from an optimum balance of target nucleus number density and thickness to maximize count rates while minimizing reaction product energy loss and straggling.

In inverse kinematics, target optimization is difficult to achieve, since the light target isotopes necessary (e.g., hydrogen, helium) cannot be easily made into targets. Traditional solid targets are often plagued with contaminants (such as carbon and oxygen) or require backing materials like aluminum or nickel that contribute substantially to straggling and background. Gas targets can eliminate some of the difficulties, but introduce others. Gas cells, for example, require thin windows which worsen energy and angular resolution, and windowless gas targets, achieved via differential pumping, are too spatially extended along the beam axis to allow angular distributions to be measured.

An advantageous solution to these difficulties is a supersonic gas jet target, which allows for a high density of target nuclei within a highly confined region. No windows or backing materials are present to produce unwanted background events, gas purity is high and the amount of contamination is well controlled, and the small target size allows for high-resolution measurements of energy and angle. Gas forced through a laval nozzle (pictured) has the high density and small dimensions necessary for a jet target, and various pumping stages, in conjunction with a diaphragm compressor, handle the flow and recirculate the gas within the system.



Above: A view of the JENSA system as installed in the ReA3 hall. Visible on the right is the dedicated beamline, with the target chamber, series of vacuum pumps, and the control panel. On the left is the industrial compressor, used to return the gas to the high pressures required to feed the jet. Left: A close-up photograph of the JENSA jet nozzle and gas receivers inside of the target chamber. Detector mounts are visible in the background.

A dense, supersonic gas jet target, coupled with charged-particle and gamma detector arrays, presents exciting opportunities for precision measurements with modest intensities of the exotic reaccelerated radioactive beams anticipated at FRIB. The Jet Experiments in Nuclear Structure and Astrophysics (JENSA) Collaboration has designed, built, and commissioned such a supersonic gas jet target system for use with FRIB beams. The JENSA system is currently installed on a dedicated beamline in the ReA3 hall (pictured). JENSA can incorporate large arrays of charged particle and gamma ray detectors, and in the future will become the dedicated target for the SECAR recoil separator to facilitate cutting-edge capture reaction measurements for astrophysics. The collaboration is also investigating the utility of a second gas jet target system in the higher-energy reaccelerated beam hall for use with the wide variety of instruments anticipated for that hall.

For more information,please visit the JENSA webpage at jensajet.org.