

Superconducting Gas-filled Separator

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A gas-filled separator consisting of superconducting magnets is being considered. The favored design consists of two 5-Tesla flat-field magnets, each with a 90-degree bend angle and a 0.5-meter bend radius for the central trajectory. With one magnet bending recoils in the horizontal direction, and the other bending in the vertical, all focusing is achieved geometrically (no focusing elements). This results in a separator with a short (2.0m) flight path, and a large (100 msr) angular acceptance. Results of preliminary calculations will be presented, and the applicability for use at FRIB will be discussed.



Purpose

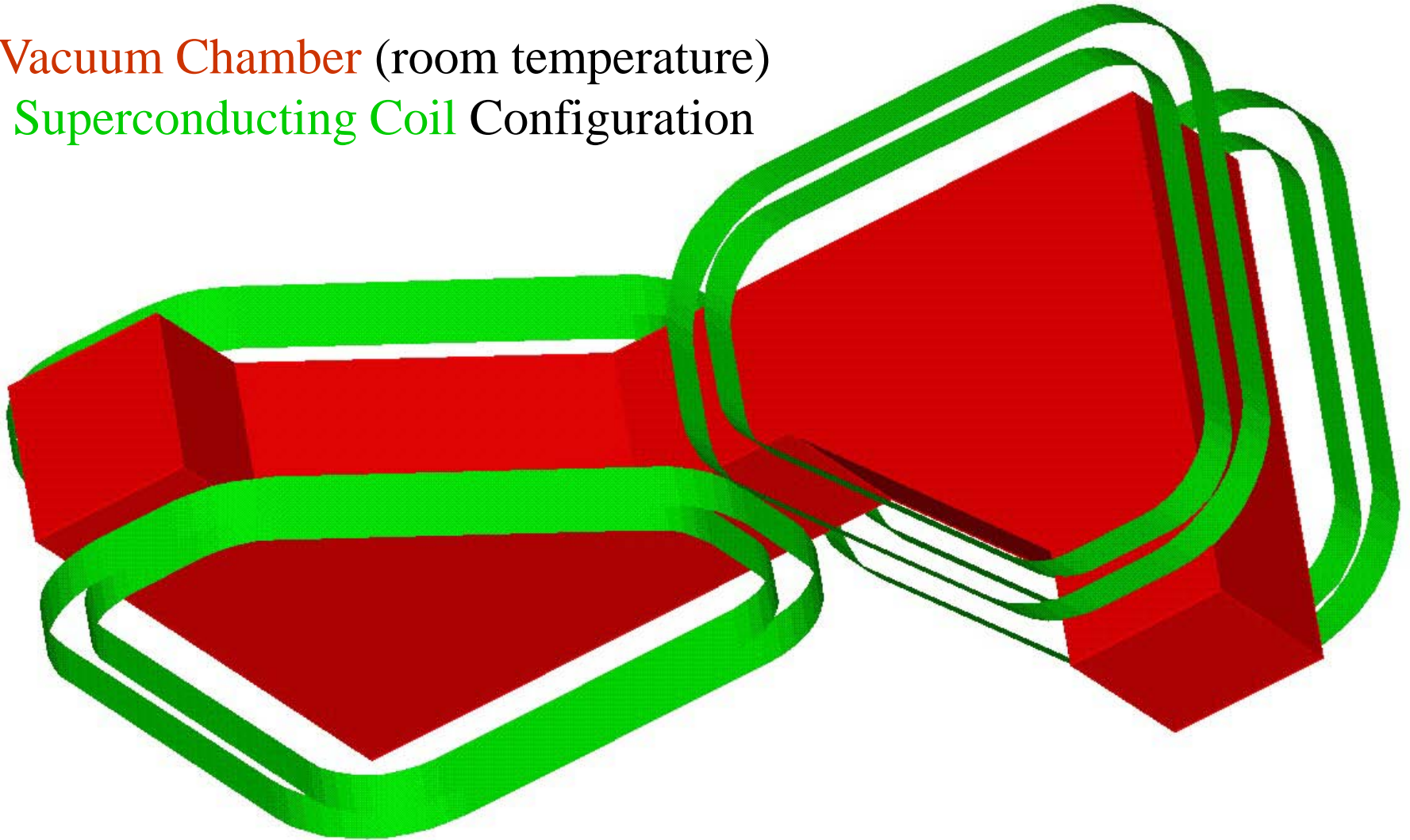
A compound nucleus separator will be used to separate the compound nuclei from the unreacted beam, scattered beam, and projectile-like and target-like products of transfer reactions.

In study of compound nucleus reactions with radioactive beams, decay of beam will make direct detection of product decay impossible.

A gas-filled magnetic separator is the most efficient means for removal of projectiles.

SGS Schematic

Vacuum Chamber (room temperature)
Superconducting Coil Configuration



Operating Principles

Compound nuclei recoil from target with momentum of beam (near 0°) into a dilute gas.

Charge exchange in gas results in well-defined average charge

Average charge is proportional to v , giving broad velocity acceptance

Magnetic separation: $B\rho = mv/q$

Beam and beam-like products at high v take on lower $B\rho$

Compound nucleus products have larger $B\rho$ than target-like transfer products and are separated according to A

SGS Specifications and comparison w/ BGS

	SGS	BGS
Magnetic configuration	$D_h D_v$	QvGhD
Maximum B.	5.0 T	1.7 T
Bend angle	90° vert + 90° horiz.	70° horiz. (25° + 45°)
Bend radius	0.5 m	
Trajectory length	2.06 m	4.62 m
Angular acceptance	$\pm 6.3^\circ$ h, $\pm 12.7^\circ$ v, 99 msr	$\pm 4.3^\circ$ h, $\pm 8.5^\circ$ v, 45 msr
Magnetic dispersion	0.74 cm/% h, 1.53 cm/% v, 1.7 cm/% total	2.02 cm/%
Image magnification	0.49 h, 2.06 v, 1.00 total	0.60 h, 7.12 v, 4.30 total
Mass resolution	$A/\Delta A \sim 80$	$A/\Delta A \sim 25$
C.N. efficiency	30% (Ne+U) – 100% (Ca+U)	15% asym. – 70% symm
Cost estimate	\$5.0M	\$1.5M

Range of Applicability

A gas-filled separator works best for heavy element studies, where suppression of beam and other reaction products is of the most importance.

Since all compound nucleus evaporation residues get to the detector, a gas-filled separator works best where “everything else fissions.”

However, a gas-filled separator will be very useful for compound nucleus studies with radioactive beams

Where it works	Where it doesn't work
Moderately asymmetric reactions with heavy targets and projectiles from O through Kr	Light projectiles ($A < 15$) Symmetric reactions Inverse kinematics
Upper half of the nuclide chart	Light reactions ($A_{CN} < 100$)
Products can be identified based on decay properties	Experiments with large amounts of compound nucleus products and non-unique decay properties

Existing Equipment with Similar Capabilities

Depending on status of Heavy Element Program and 88-Inch Cyclotron, BGS could move to FRIB when it comes on-line.

However, these are 50 year-old magnets.

