The HIE-ISOLDE Superconducting Recoil Separator


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Introduction

The HIE-ISOLDE facility at CERN (Geneva, Switzerland) [1] produces a large variety of radioactive beams from ³²⁵Ra to ⁷⁸⁷Ra at 0.45-10 MeV/u. This energy range is ideal to study nuclear structure, low-energy dynamics and astrophysics.

Physics Program

The Whacko-Bot facility, addressing the relevant physics questions is presently in preparation. This will define the technical requirements.

Physics cases

- Direct reactions
- Transfer
- Couls
- Deep inelastic
- Fusion-evaporation
- Astrophysics
- Focal plane decay
- Beyond HIE-ISOLDE

Profit from existing detectors

- MINIBALL, BEC, ISS

Superconducting Recoil Separator

To meet the physics program needs, a high-resolution recoil separator based on a compact superconducting (SC) mini-ring storage system has been proposed [2]. A proof-of-concept preliminary design features a ⌀ ≈ 1.5 m diameter ring built up of multilayered SC magnets [3] of ≈ 25 cm length (MPSMC) in a FixedField Alternating-Gradient (FFAG) configuration. The MPSMCs should be able to withstand magnetic fields as high as 4 to 6 T. HTS materials and cryocooler systems will be considered in the design. Preliminary beam dynamics studies are ongoing (J. Resta –López, Cockcroft Institute, UK) [4].

Reaction fragments circulate up to r ~ 1 m being differentiated by their cyclotron frequency. Various techniques of operation are under study. In the simplest mode, the ions are extracted, identified and quantified in a focal plane detector by Time-of-Flight (ToF) and Energy Loss in Gas – Si detectors. Digital Pulse Shape Analysis (DPSA) techniques will help to deal with the most challenging cases.

Simulations

d[²³³²³⁷Ræ²³⁷Ræ] \( \rightarrow 10 \) MeV/u

Multiharmonic buncher

A bunch spacing of 100 – 500 ns is needed for operating the spectrometer in ToF mode. This can be achieved by using a multiharmonic buncher (MHB) and a dedicated EBIS extraction mode. A single-gap, grid-less MHB, similar to ATLAS in ANL [5], is being developed from previous studies [6].

References

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