Design study of a reaction chamber for the ISOLDE Superconducting Recoil Separator- LOI-INTC-228 (2021)

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ISOLDE Superconducting Recoil Separator

Abstract

The ISOLDE Superconducting Fragment Separator (ISRS) [1, 2] is an innovative a high-resolution spectrometer foreseen to study the structure and dynamics of radioactive nuclei at HIE-ISOLDE. The scientific program requires the use of a variety of nuclear reactions including Coulomb breakup/dissociation, fusion-evaporation, and transfer reactions in direct and inverse kinematics. Part of the foreseen reactions involve the rotation of ISRS to analyze heavy fragments ejected at angles as large as 70 degree. The chamber should be also suitable to be used in combination with neutron and gamma arrays, and for hosting light-ion solid-state detectors. The design of the ISRS scattering chamber is therefore a very challenging part of the project as it has to accomplish several detector constraints as well as those of the ISRS particle spectrometer itself. We present and discuss the design study of an innovative reaction chamber able to rotate and accommodate most of the requirements of the physics program. The reaction chamber will be installed at the ion-test bench of MAGDEM for in-beam experiments.

ISRS

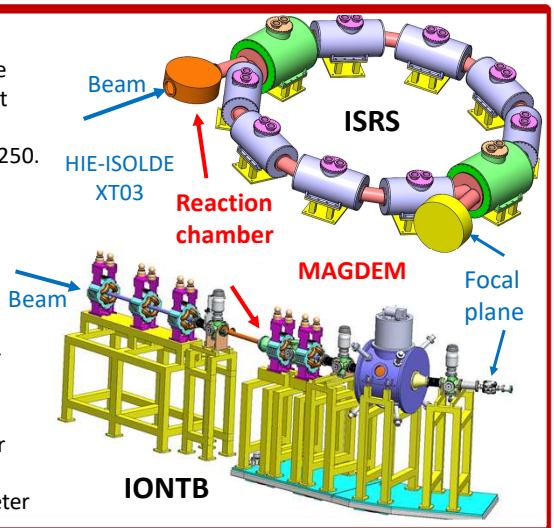
High-resolution large acceptance fragment separator with high resolving power >1/250.

Main subsystems:

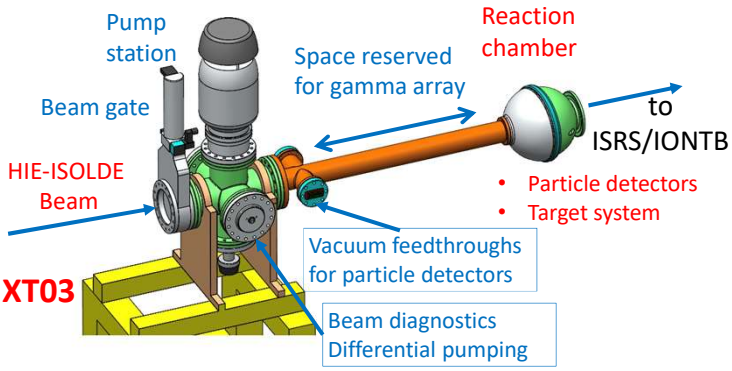
Reaction chamber
Injection
MAGDEM
Extraction
Focal plane detector

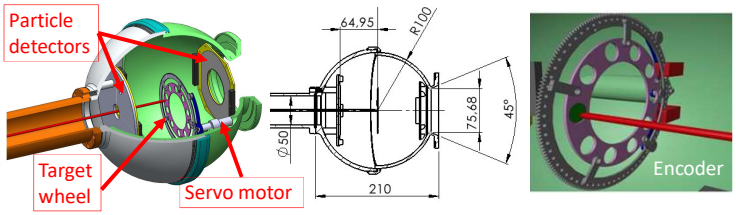
IONTB

- Ion test bench for MAGDEM
- Linear spectrometer

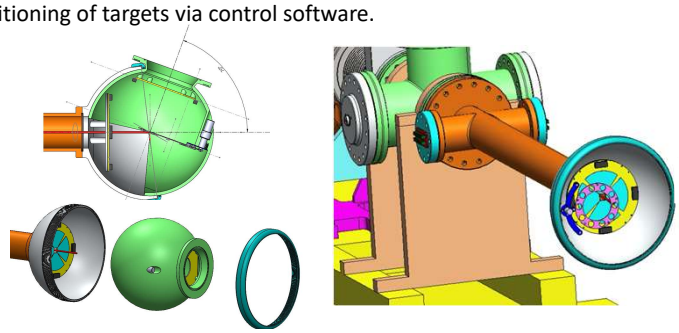


The ISRS reaction chamber must provide maximum aperture for reaction fragments, a vacuum-tight rotation system, and the possibility to install the targets. It must have also a small diameter to accommodate a gamma detector array outside. This is a general equipment for ISRS and IONTB.

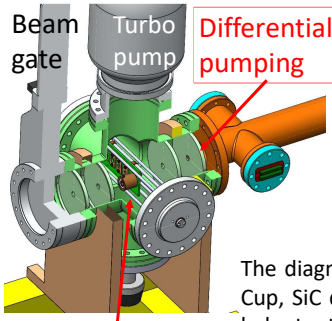




The reaction chamber has a small outer diameter of only 100 mm to increase gamma detectors solid angle, and a 45° angular aperture for the reaction recoils. Particle detectors can be placed inside, backward-forward CD segmented Silicon detectors are shown as example. A servo motor with dual optical switches and encoded gear allows for calibration and precise positioning of targets via control software.



The forward hemisphere can be rotated anti-clockwise up to 70° as required by the experiments. The vacuum system is based on a vacuum-tight washer threaded on the backward using an elastomer vacuum seal (o-ring). Vacuum limit is ~ 10^{-6} mb but isolated from HIE-ISOLDE by the differential pumping system.



The differential pumping system at the entrance will preserve the ISRS vacuum level to ensure safe opening to the HIE-ISOLDE side. It is composed of a set of two double diaphragms and a turbopump (typical Φ/5mm, G/400 l/s). The assembly must provide a vacuum level below 10^{-7} mb.

The diagnostics system is composed of a Faraday Cup, SiC detector, and a set of collimators. It will help to tune pilot & radioactive beams at the entrance of ISRS/IONTB.

Summary and Conclusions

- **Innovative Design:** A new reaction chamber for the ISOLDE Superconducting Recoil Separator (ISRS) has been developed.
- **Rotation Capability:** The chamber can rotate up to 70°.
- **Large Aperture:** It features a large aperture of 45°.
- **Versatility:** The design accommodates the installation of particle and gamma arrays, meeting the requirements of the physics program.
- **Compatibility:** The chamber can also be installed on the ion-test bench of MAGDEM (IONTB) for in-beam experiments.

References

[1] I. Martel et al,LOI "Design study of a Superconducting Recoil Separator for HIE-ISOLDE", INTC-I-228, 2021.
[2] ISRS project web site, www.uhu.es/isrs/
[3] D. Gómez-Domínguez et al., *An ion-beam test bench for the CCT magnet prototype (MAGDEM) of the ISOLDE Superconducting Recoil Separator*, poster contribution to this workshop.

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