PROGRESS ON BEAM DYNAMICS STUDIES FOR ISRS

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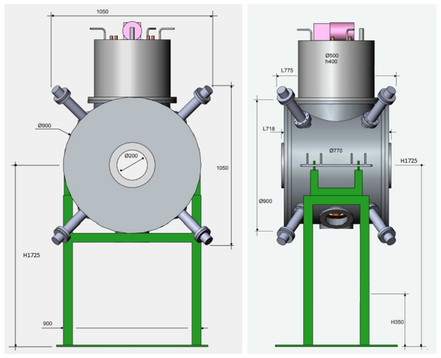
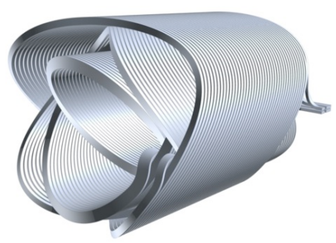
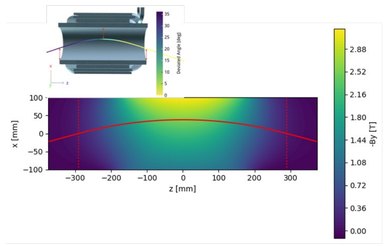
Abstract

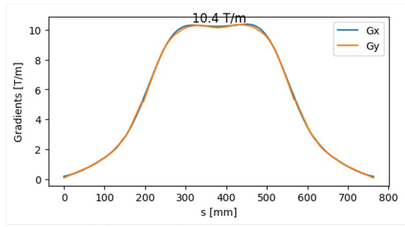
In order to accommodate an innovative spectrometer within a limited experimental hall space (5x5 meters) for HIE-ISOLDE, a new lattice configuration for the ISRS ring is proposed. This lattice consists of ten combined-function canted cosine-theta (CCT) superconducting magnets, while different approaches are being considered for the injection and extraction subsystems. The challenging integration of these magnets into the lattice considers realistic dimensions, including the cryomodules that house the strongly curved magnets, based on the recent design of a demonstrator (MAGDEM), which is planned for future fabrication. For the commissioning phase, the separation power of the spectrometer for various isotope ions has been studied in a linear spectrometer configuration.

MAGDEM





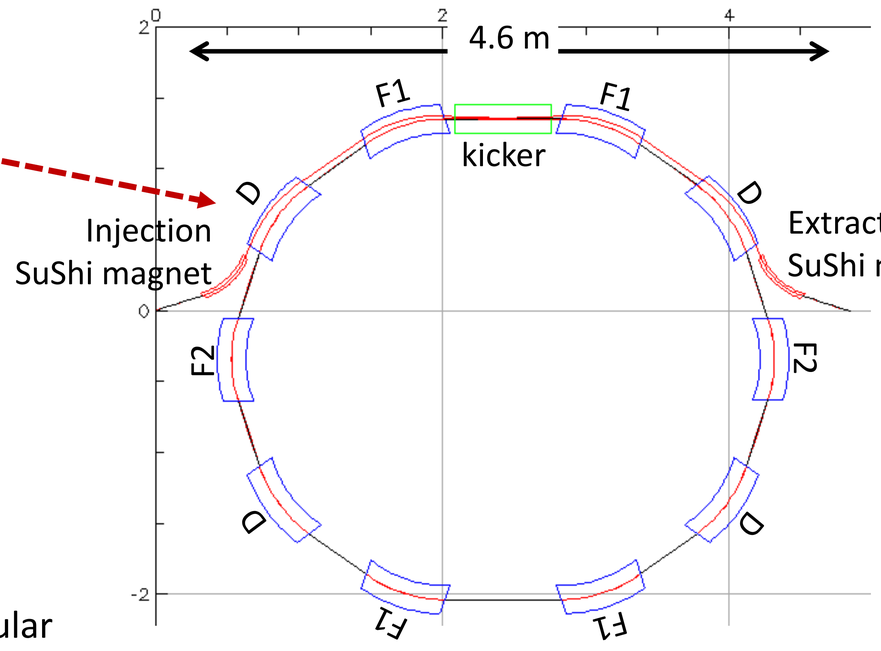




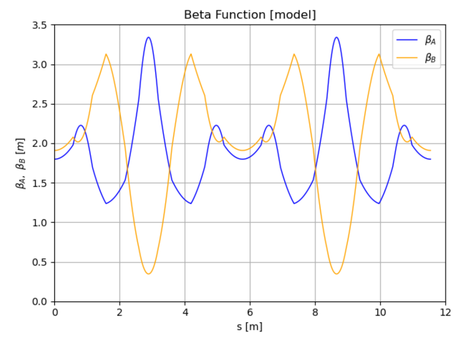
The previous ring design offered a rectangular configuration using four 90-degree combined-function CCT dipoles with an alternating gradient scheme. The construction of these magnets remains a challenge in the current state of the art, and efforts are underway to build a **demonstrator**, **MAGDEM**, with a smaller curvature. Technical specifications:

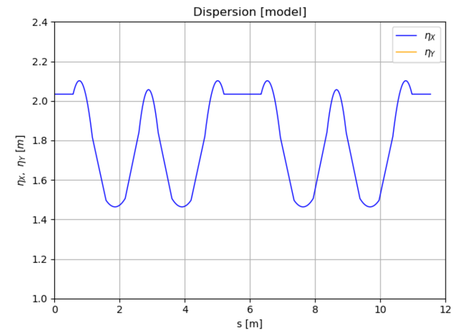
Bending angle	36 deg
Max B field at centre	2.35 T
Max gradient at centre	10 T/m
Effective length	580 mm
Aperture	200 mm
External dimensions (including cryostat)	900 mm diameter 720 mm length

New ring baseline design

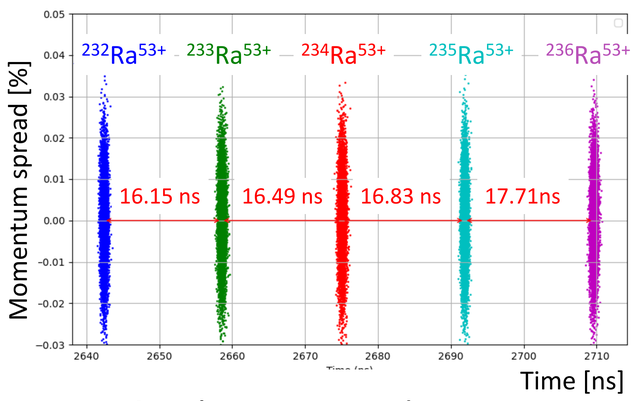


Isochronous ring optics

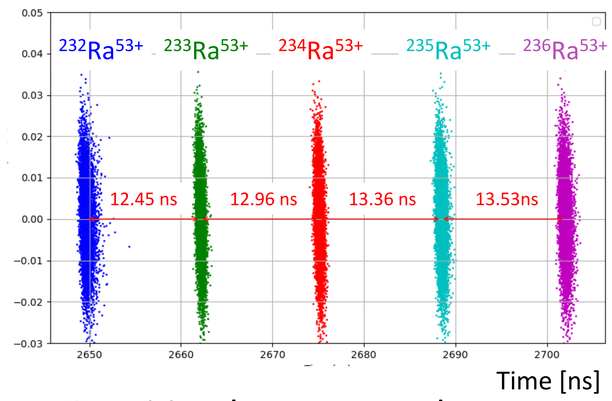




Isotopes separation by ToF after 10 turns:



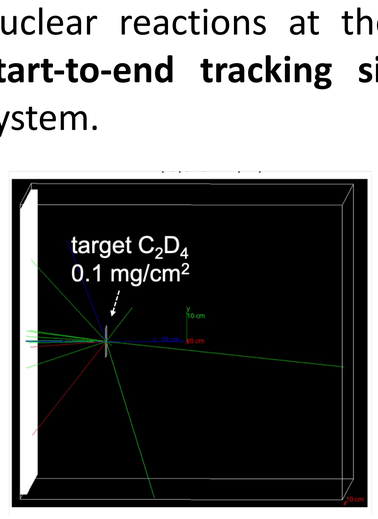
Isochronous mode
(momentum acceptance 4.8 %)



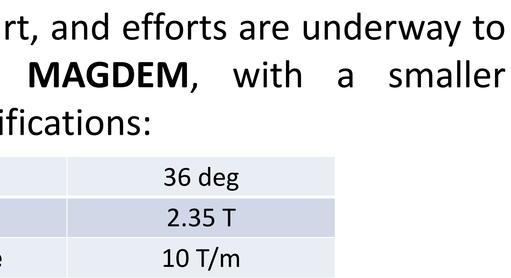
Quasi-isochronous mode
(momentum acceptance 6.7 %)

Input beam characterization

MonteCarlo simulations with a GEANT4 model of the nuclear reactions at the target allows for **realistic start-to-end tracking simulations** in the ISRS full system.



Phase-space distribution of reaction products

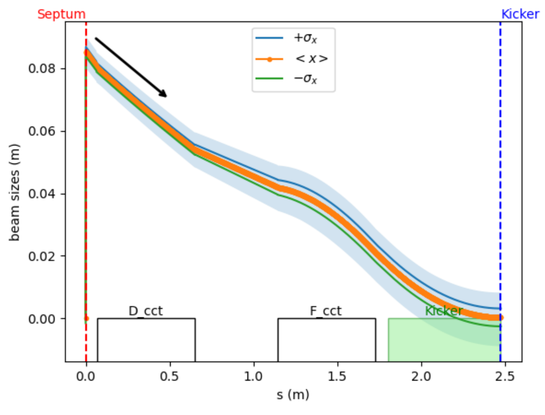


Injection and Extraction subsystems

In one straight section between both branches, a space is left to integrate **magnetic kicker** for injection/extraction. The limited space requires the use of two CCT magnets to minimize the kick angle as much as possible with the action of the quadrupoles. The challenge lies on integrating the septum between two magnets.

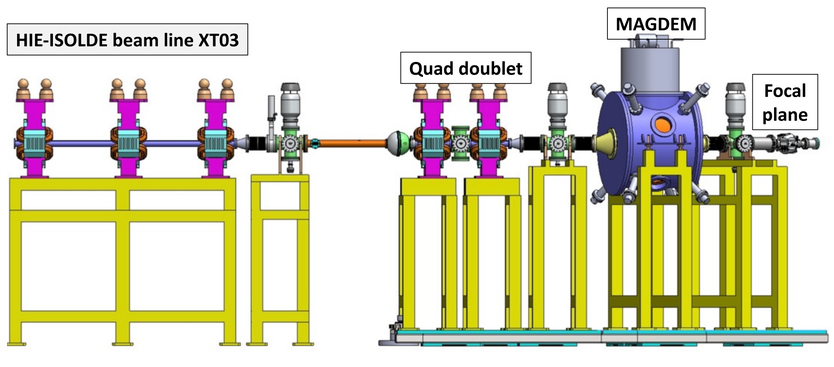
SuShi septum	
Bending angle	45 deg
Effective length	400 mm
Magnetic field	3.8 T

Magnetic kicker	
Kick angle	50 mrad
Length	600 mm
Magnetic field	0.16 T
Integrated field	0.1 T·m
Pulse rise/fall time	300 ns



MAGDEM commissioning in ion test bench

Simulations on Li isotopes separation power in a linear spectrometer configuration.



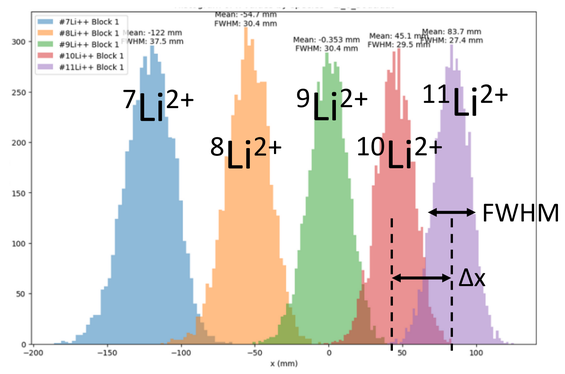


Figure of merit of mass discrimination quality: $\mathrm{FoM} = \frac{\Delta x}{\mathrm{FWHM}_1 + \mathrm{FWHM}_2} > 0.7$

References

[1] J. Resta-Lopez et al. Design of a compact superconducting recoil separator for HIE-ISOLDE. Proc. of IPAC23, Venice, Italy (2023)
[2] I. Martel et al, Letter of Intent "Design study of a Superconducting Recoil Separator for HIEISOLDE", INTC-I-228 (2021)
[3] N. Deelen and G. Kirby. A CCT for MAGDEM - Conceptual Design Report. Technical Report (2024)
[4] I. Martel et al. An innovative Superconducting Recoil Separator for HIE-ISOLDE. Nuclear Instruments and Methods in Physics Research B 541 (2023) 176–179
[5] D. Barna et al. The Superconducting Shield (SuShi) Septum Magnet Prototype. IEEE Trans. On Applied Superconductivity, vol. 32, no. 6 (2022)

https://www.uhu.es/isrs/project-isrs-spain/

https://www.uv.es/resta/NOVAS/Home.html

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