Beam dynamics calculations of the ADIGE injector for the SPES Project

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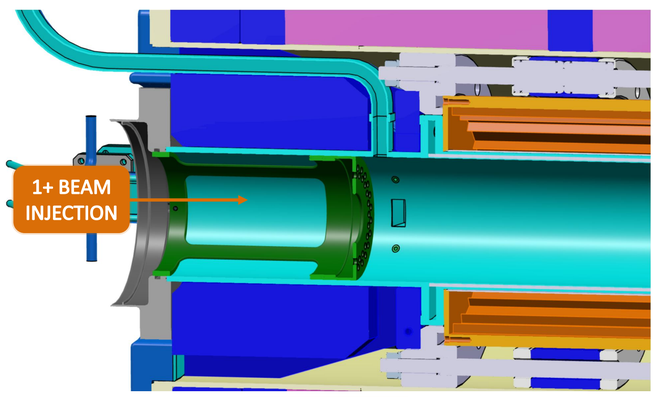
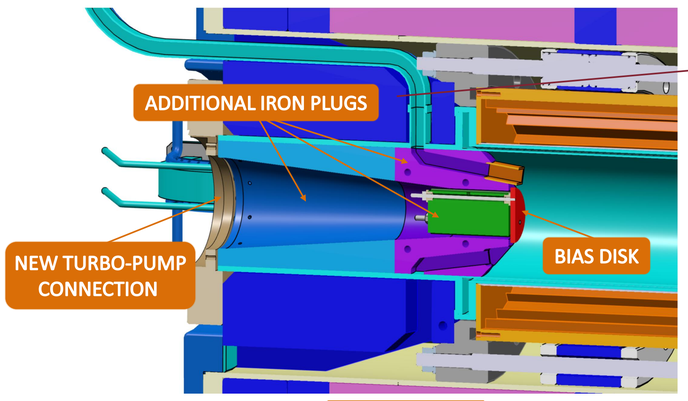
Abstract. The ADIGE injector will be the first part of the post-acceleration of radioactive ions produced in the framework of the SPES project at INFN - Legnaro National Laboratories. The beam extracted from an ECR-based Charge Breeder (CB) will be transported toward a medium-resolution mass spectrometer (MRMS, resolving power 1/1000), installed on a negatively polarized high-voltage platform, and then injected into an RFQ through a magnetic beamline. Aim of the MRMS is to purify the extracted beam from the contaminants induced by the breeding process. The commissioning of the injector will start in Autumn 2025, using stable beams of increasing mass produced by turning the charge breeder into a conventional ion source. This contribution presents a numerical characterization of the CB extraction system and its downstream transport line, starting from the case study of a $^{132}Sn^{19+}$ beam, being the most representative radioactive ion for the SPES project. The study revealed important information on the transport line's sensitivity to the initial beam parameters and proved to be very useful in estimating to which extent they can be scaled, following the mass-over-charge ratio of the transported ion. Preliminary considerations on the MRMS operation during an ion scan will be also reported.

ECR-CB modification in ion source.



BEFORE



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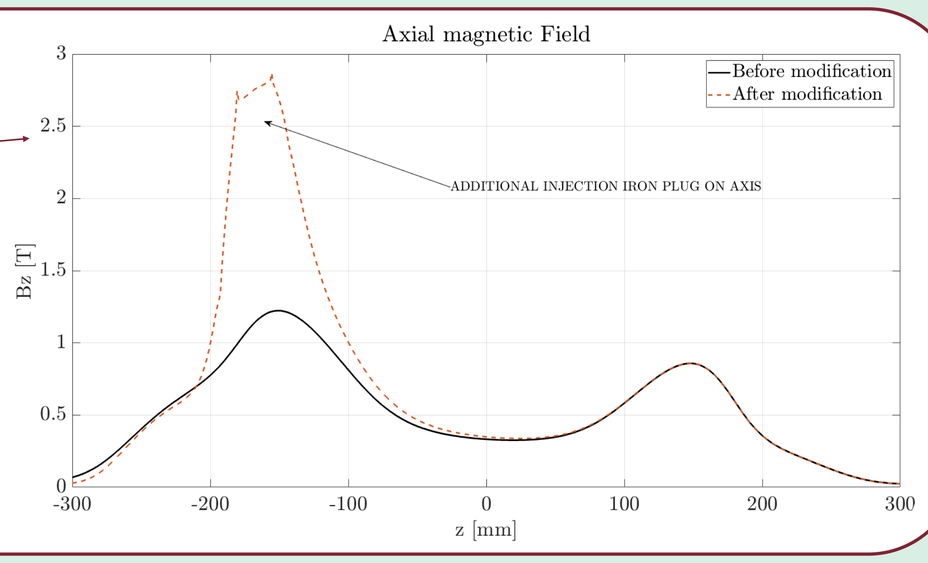
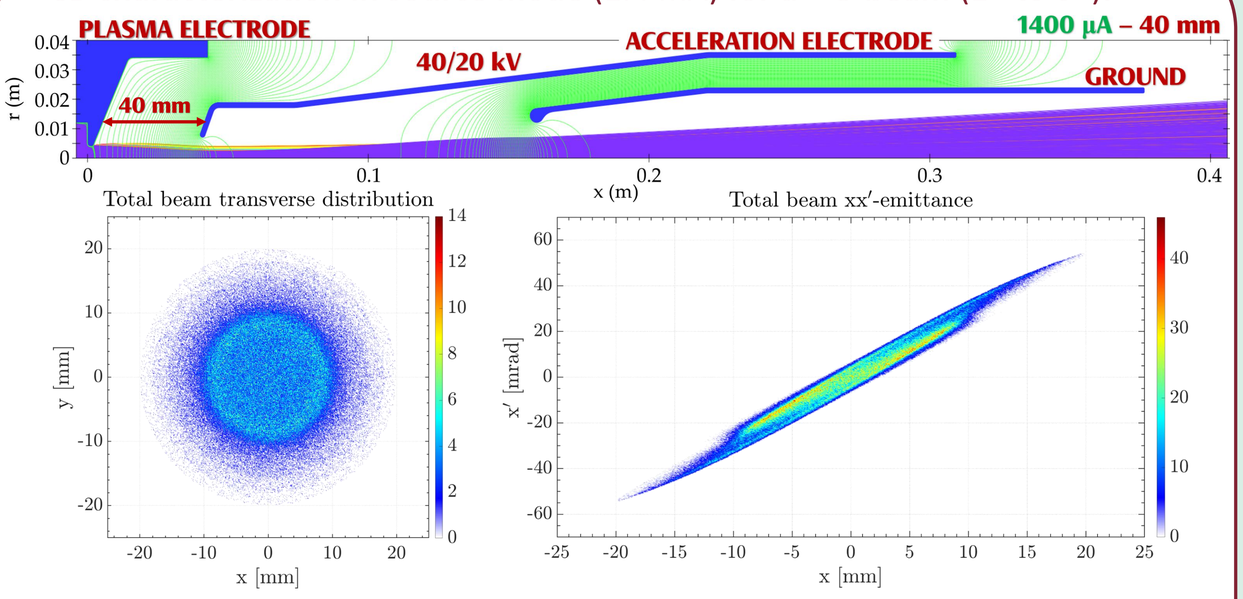


CB characterization in source mode (1.4 mA) for a ^{16}O beam (1+ to 6+).

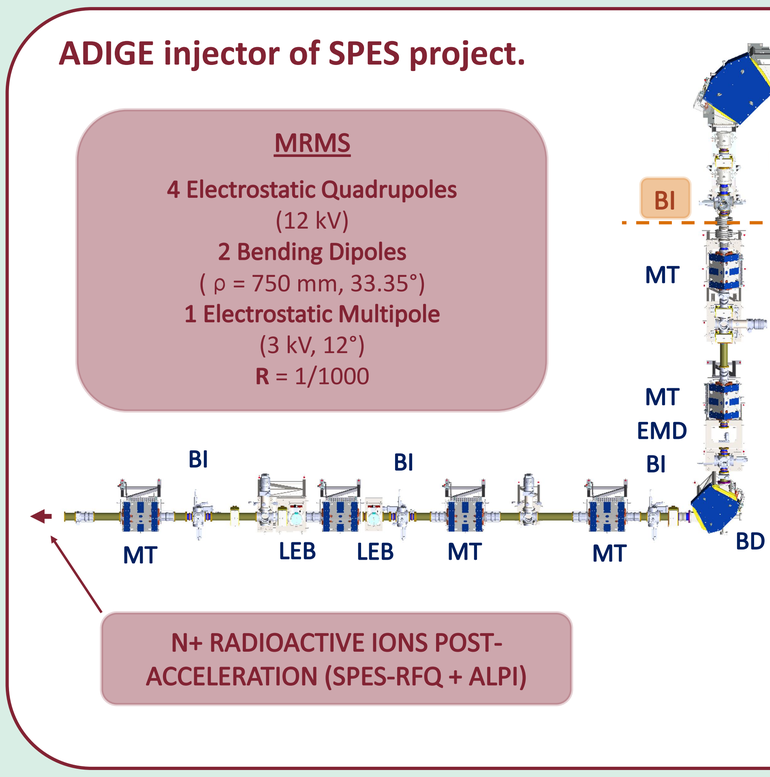


ε_{rms} (mm.mrad)	α	β	x_{max} (mm)	x'_{max} (mrad)
26.6366	-4.77866	1.5392	6.40305	20.3098

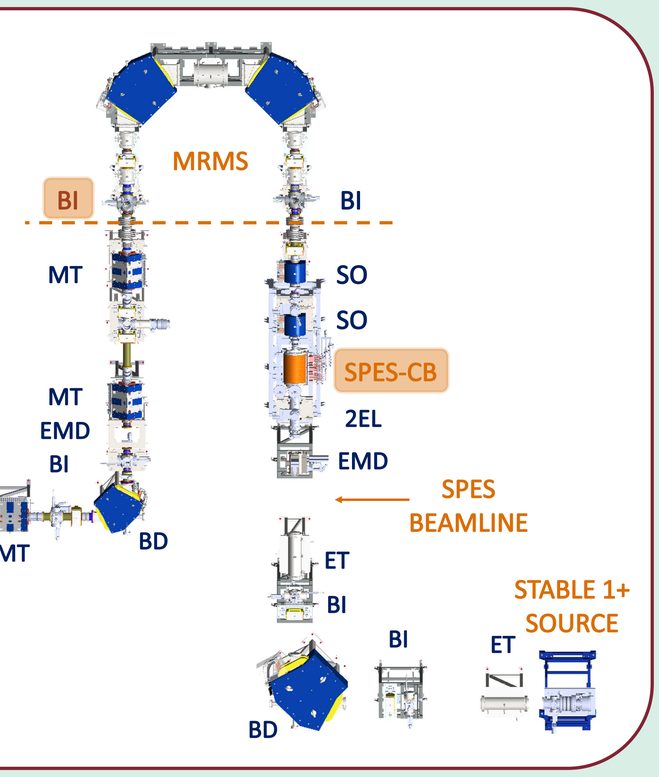
ADIGE injector of SPES project.

MRMS

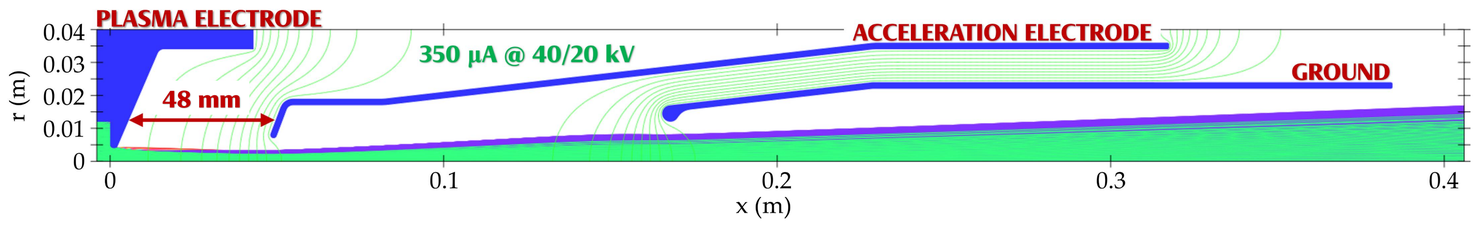
4 Electrostatic Quadrupoles
(12 kV)
2 Bending Dipoles
(ρ = 750 mm, 33.35°)
1 Electrostatic Multipole
(3 kV, 12°)
R = 1/1000



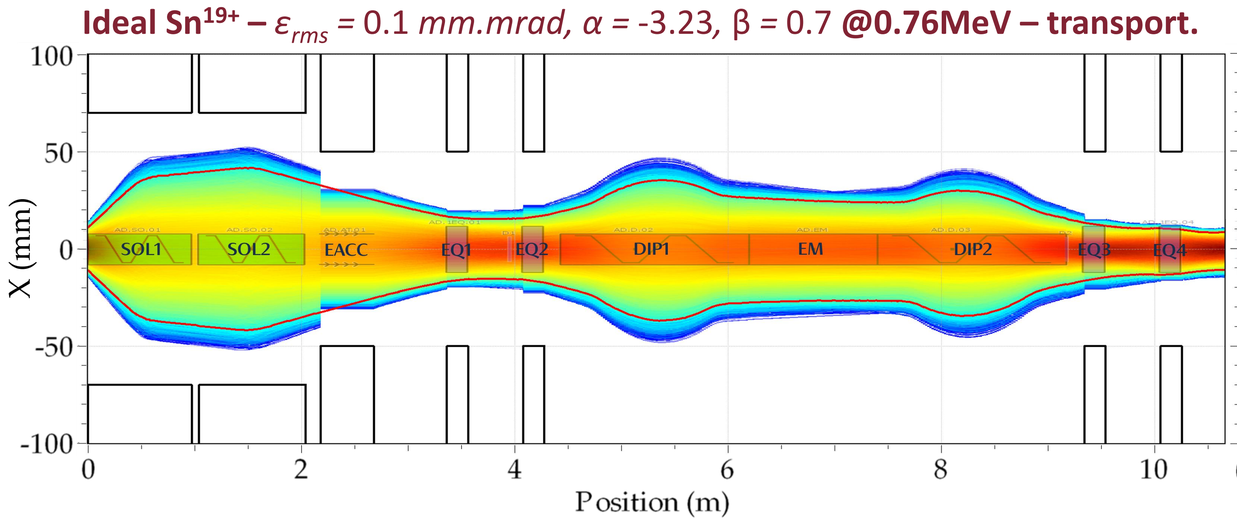
N+ RADIOACTIVE IONS POST-ACCELERATION (SPES-RFQ + ALPI)



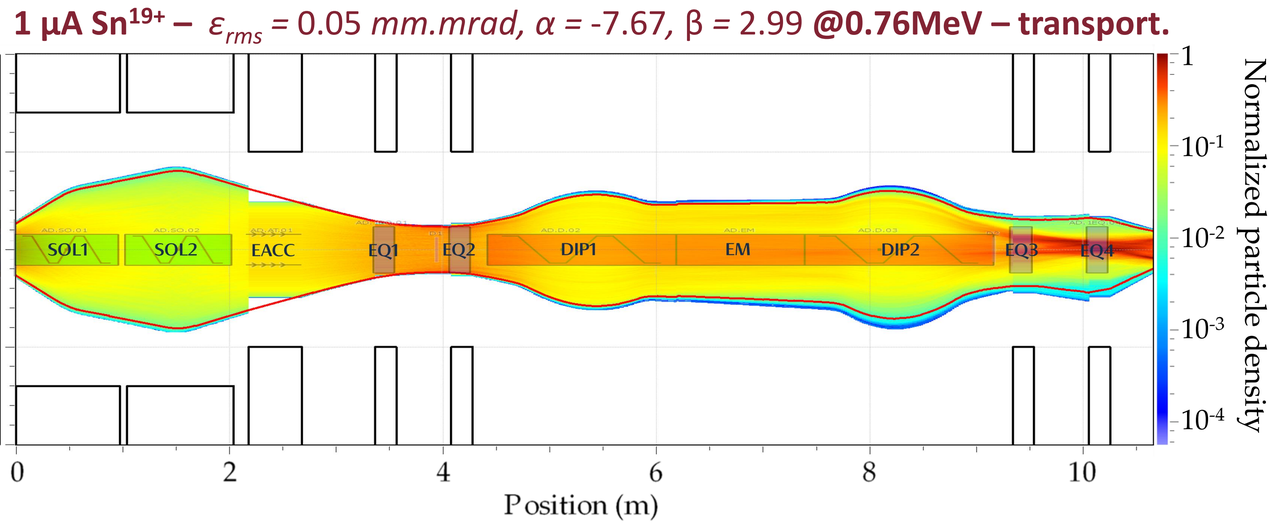
^{16}O (1+ to 6+) and ^{132}Sn (19+) extraction (d = 48 mm @ 350 µA).



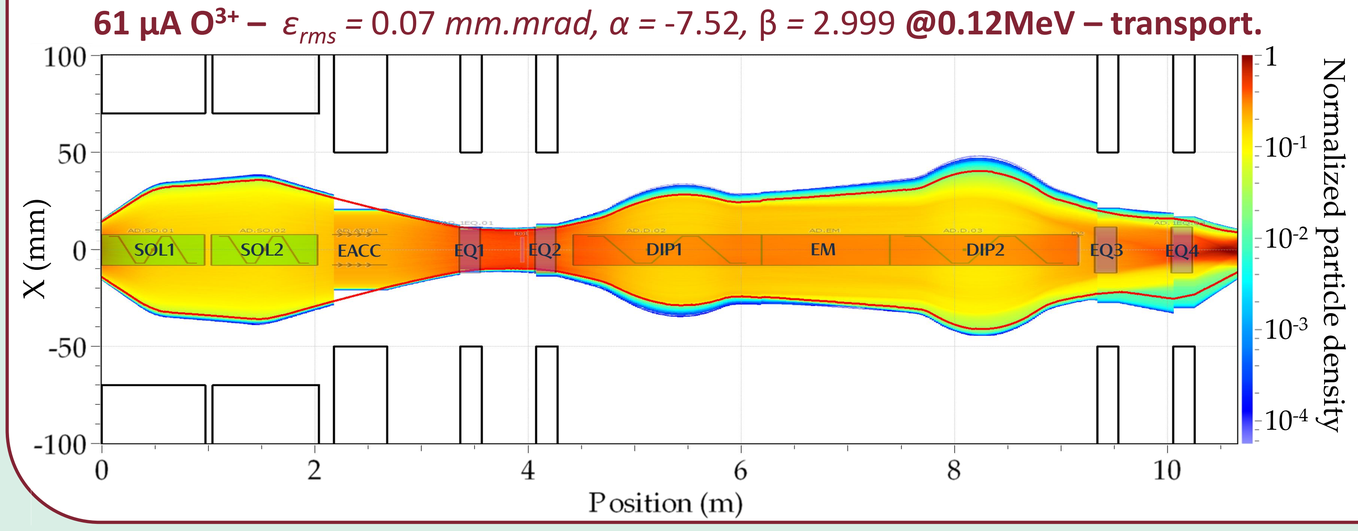
Ideal Sn^{19+} – ε_{rms} = 0.1 *mm.mrad*, α = -3.23, β = 0.7 @0.76MeV – transport.



1 µA Sn^{19+} – ε_{rms} = 0.05 *mm.mrad*, α = -7.67, β = 2.99 @0.76MeV – transport.



61 µA O^{3+} – ε_{rms} = 0.07 *mm.mrad*, α = -7.52, β = 2.999 @0.12MeV – transport.



OPTIMIZATION PARAMETERS

Ions	B_{SOL1} (T)	B_{SOL2} (T)	B_{DIP} (T)	V_{EQ1} (V)	V_{EQ2} (V)	V_{EQ3} (V)	V_{EQ4} (V)
Ideal Sn^{19+}	0.342	0.207	-0.100351	-442.42	-627.85	-279.21	1505.55
Real Sn^{19+}	0.271	0.241	-0.100336	-442.42	-627.85	-279.21	1505.55
Real O^{3+}	0.267	0.196	-0.087916	-442.42	-627.85	-279.21	1505.55