Upgrade of the GTS Electron Cyclotron Resonance Ion Source at GANIL

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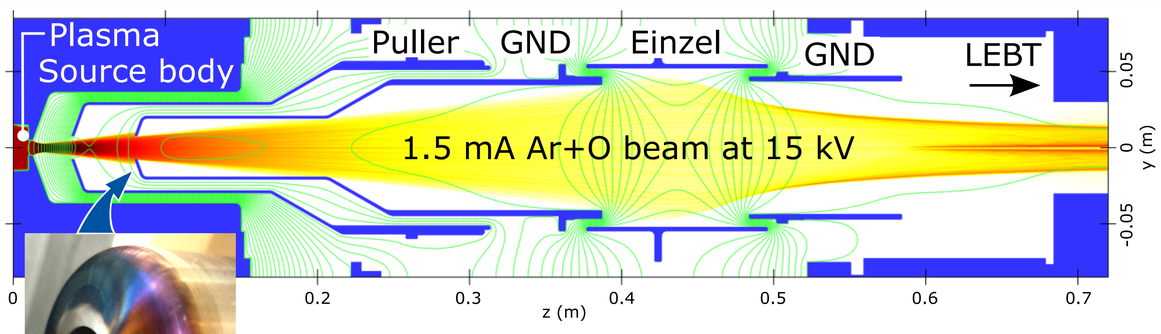
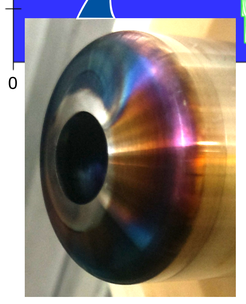
ABSTRACT

The GTS (Grenoble Test Source) electron cyclotron resonance ion source, operated at 14.5 GHz, provides multiply charged heavy ion beams for the ARIBE (Accélérateurs pour les Recherches Interdisciplinaires avec les Ions de Basse Energie) facility at GANIL (Grand Accélérateur National d'Ions Lourds). In order to increase the beam currents and charge states available for experiments and to have a test bench with good performance for the R&D of new beams for GANIL users, the ion source has undergone a number of upgrades. These include the refurbishment of the extraction system and the addition of a new central coil. The injection side of the source will also be replaced in the future. A simulation approach has been used in parallel to the upgrades to identify potential performance limitations in the beam extraction and low energy beam transport sections. In addition, metal ion beam production with the MIVOC (Metal Ions from VOlatile Compounds) method has been tested for the first time with the GTS to expand the beam catalog available for the ARIBE experiments. The performance of the upgraded GTS is presented along with the results from the simulation studies and the MIVOC tests.

1 EXTRACTION REFURBISHMENT





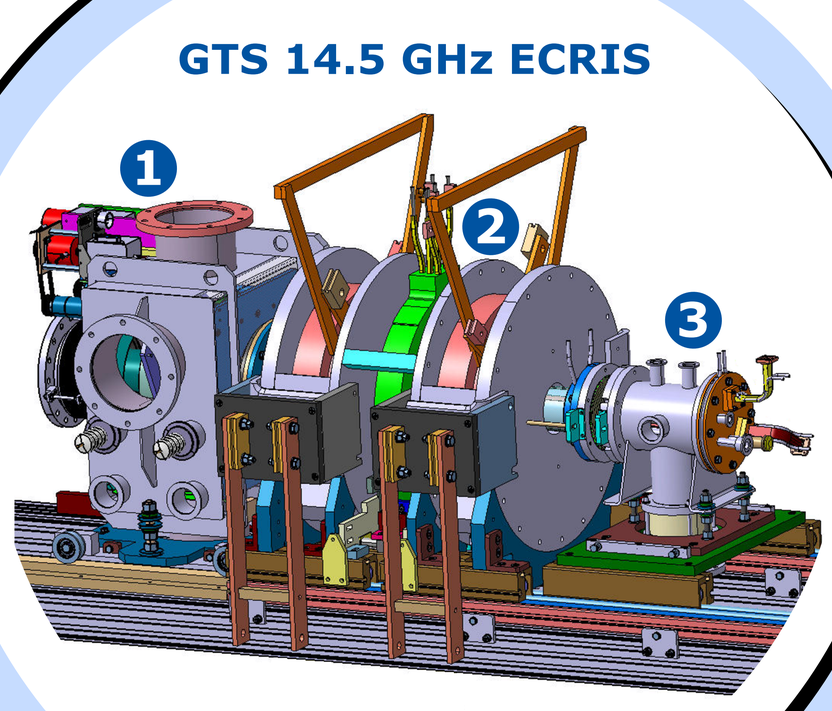
Problems with the old system

- Penning discharges limited operation <15 kV
- Electrodes had been truncated to mitigate discharges
- Poor beam quality and LEBT transmission

New refurbished extraction system

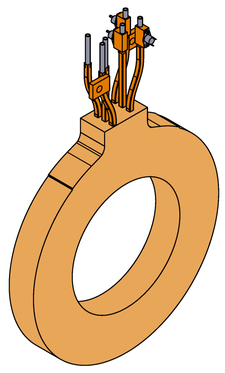
- Truncated aluminum electrodes replaced with properly shaped stainless steel ones
- Improved pumping in extraction
- No discharges, reliable operation from a few kV to 25 kV
- Simulation of the new system above, good correlation with observations

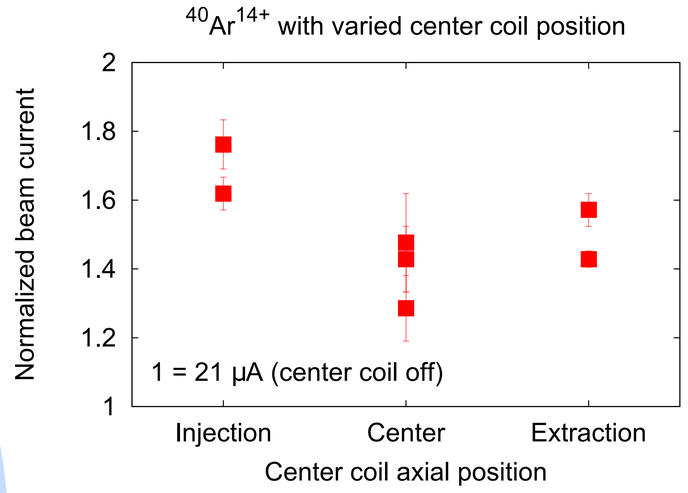
GTS 14.5 GHz ECRIS



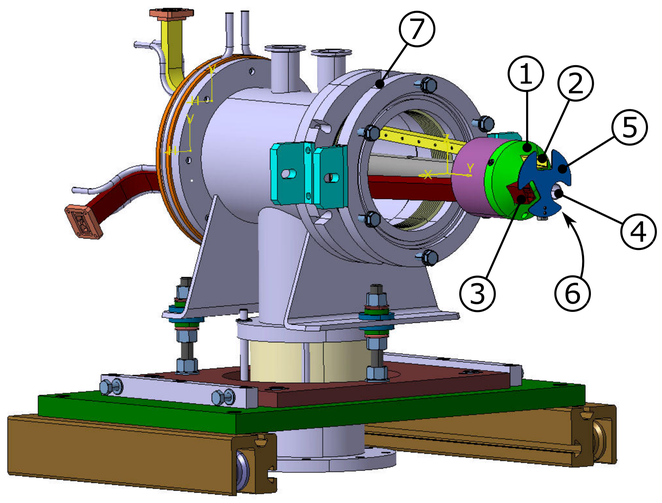
2 NEW CENTER COIL

- New center coil installed between injection and extraction coils, movable ±25 mm from center point
- Improved magnetic field control, especially for minimum B field
- Clear influence on beam stability and performance
- Optimum performance reached with GTS when:
  - Center coil polarity the same as the main coils
  - Coil placed axially at the injection side of the source (25 mm from the center)





3 INJECTION REDESIGN

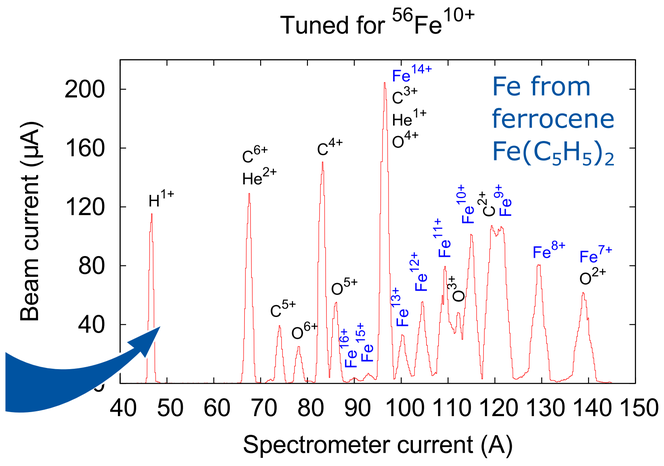


1 Vanadium permendur nose cone (+10% injection field)
2 3 WR62 + WRD750 waveguides (wide 8-18 GHz frequency range)
4 Oven/MIVOC port, compatible with GANIL equipment
5 Biased disc with increased size
6 Dedicated gas input (not visible in the figure)
7 Bellows to allow adjustment of injection plug axial position

- **Scheduled to be installed at the end of 2017**

RESULTS: PERFORMANCE

MIVOC tested for the first time with GTS



- Up to a factor of three improvement in the beam currents
- LEBT transmission is still a major bottle neck, currently <50%
- Performance with selected beams at 15 kV without the new injection (charge state for which the source was optimized is in parenthesis):

He/S	I(μA)	Ne	I(μA)	Ar/Kr	I(μA)	Xe	I(μA)
$^{3}He^{1+}$ (1+)	1530	$^{20}Ne^{5+}$ (6+)	168	$^{40}Ar^{13+}$ (14+)	59	$^{129}Xe^{25+}$ (25+)	63
$^{3}He^{2+}$ (2+)	1510	$^{20}Ne^{6+}$ (6+)	185	$^{40}Ar^{14+}$ (14+)	37	$^{129}Xe^{26+}$ (25+)	56
$^{32}S^{9+}$ (11+)	88	$^{22}Ne^{7+}$ (9+)	153	$^{40}Ar^{16+}$ (16+)	6	$^{129}Xe^{27+}$ (25+)	36
$^{32}S^{11+}$ (11+)	23	$^{22}Ne^{8+}$ (9+)	224	$^{84}Kr^{22+}$ (23+)	27	$^{129}Xe^{28+}$ (25+)	22
$^{32}S^{13+}$ (11+)	2	$^{22}Ne^{9+}$ (9+)	32	$^{84}Kr^{23+}$ (23+)	25	$^{129}Xe^{29+}$ (25+)	9
		$^{22}Ne^{10+}$ (9+)	4	$^{84}Kr^{25+}$ (23+)	14	$^{129}Xe^{30+}$ (25+)	3

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