GISMO Gasdynamic ECR Ion Source Status: Towards High-Intensity Ion Beams of Superior Quality

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The first gasdynamic ECRIS: SMIS37

Frequency 37.5 or 75 GHz
Power up to 100 kW
Pulse duration 1 ms
Trap magnetic field up to 5 T

Low temperature high density collisional plasma

Unique plasma parameters
\[ N_e > 10^{13} \text{ cm}^{-3}, \tau = 5 \div 50 \text{ us}, \]
\[ T_e: 50 \div 300 \text{ eV} \]

High current density
\[ J \sim 100 - 800 \text{ mA/cm}^2 \]

Low emittance values
The first gasdynamic ECRIS: SMIS37

H+, D+ Ions current density > 600 mA/cm²

Emittance: <0.07 π*mm*mrad might be even less, low measurement accuracy

Molecular ions: <6% of the beam
GISMO ECR ion source

Water colling plasma chamber and permanent magnet trap
Gaussian beam to TE11 converter
Microwave coupling system
100 kV quasioptical DC break

Diagnostic chamber
100 kV HV insulator

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Ivan Izotov; MOWZO04
GISMO plasma chamber

Handles 10 kW of CW power keeping the magnets below 30 °C

>95% efficiency of μw transport
$J \sim 1000 \text{ mA/cm}^2 \ [\text{drain}]$

$E_{\text{rms, norm}} < 0.2 \pi \cdot \text{mm} \cdot \text{mrad}$

We need a sophisticated extraction system!
New extraction system: spherical

PSST: under review

Patent #2726143 (Russian Federation)
Large puller aperture barely affects the beam

Despite the native transverse E-field, the spherical extractor may enhance the beam divergence due to lower influence of the space charge.
In combination with intrinsic magnetic lenses, the spherical extractor allowed us to achieve >60 mA of H+ beam at 40 keV. Beam size (>99%) is 50 mm at 70 cm from the extraction system. Yet >100 mA are lost in the beam line (puller) and may be delivered with the enhanced multi-electrode beam forming configuration.
Beam losses

PULLER

- 2.5 mTorr; 1.45 kW
- 2.5 mTorr; 2.9 kW
- 2.5 mTorr; 4.6 kW

- 95 mm
- 130 mm
- 210 mm
Ion beam composition: impurities

- $H^+$
- $H_2^+$
Ion beam composition: $H^+ / H_2^+$ ratio

Pure proton beam with no need to separate
VUV emission

180±20 nm

160±10 nm

122±10 nm

VUV diode
Conclusion and possible applications

● Plasma emissivity >1000 mA/cm²

● Emittance: precise measurements are in progress, preliminary results showed $E_{\text{rms, norm}} < 0.2 \, \pi \cdot \text{mm} \cdot \text{mrad}$

● With proper extraction system it may be possible to fulfill requirements of such projects as ISIS-II (250 mA, $E_{\text{rms}}<0.1$) and DARIA (100 mA, $E_{\text{rms}}<0.2$). New extractor is in production.

● GISMO may be an intense source of VUV

● D+ beams may be successfully used to produce wide neutron fluxes for BNCT and to implement a point-like neutron source for fast neutron imaging
Dozens of kW in a CW beam: challenging :)