Alphatross Source RF-Charge Exchange Ion Source

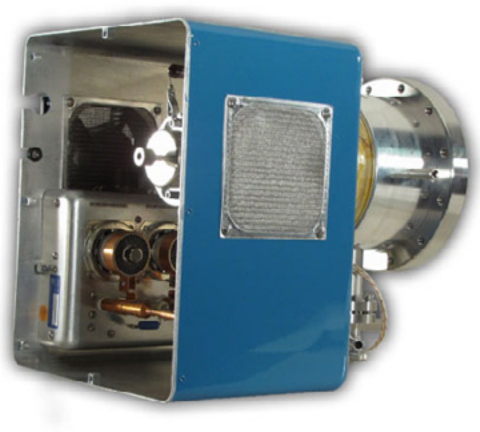
The NEC RF-charge exchange ion source, henceforth referred to as the Alphatross source, was designed primarily for the production of He^- beams for injection into tandem accelerators. Its use has been expanded to include H^-, NH^- and O^- beams. There are more than one hundred Alphatross sources in use on tandem accelerators worldwide.

APPLICATIONS

Modern MeV ion beam analysis instruments require a long lived and simple-to-operate source of He^-, H^-, and NH^- beams. The NEC's Alphatross RF charge exchange ion source satisfies these requirements.

H^- is primarily used for Particle-induced X-ray Emission (PIXE) and Nuclear Reaction Analysis (NRA) applications, while H^- is primarily used for Rutherford Backscattering (RBS). NH^- produces an N^+ beam, which is primarily used in NRA to profile H with 15N.

The Alphatross source is a compact, reliable source of light negative ions. A positive RF source injects immediately into a compact rubidium charge exchange cell.



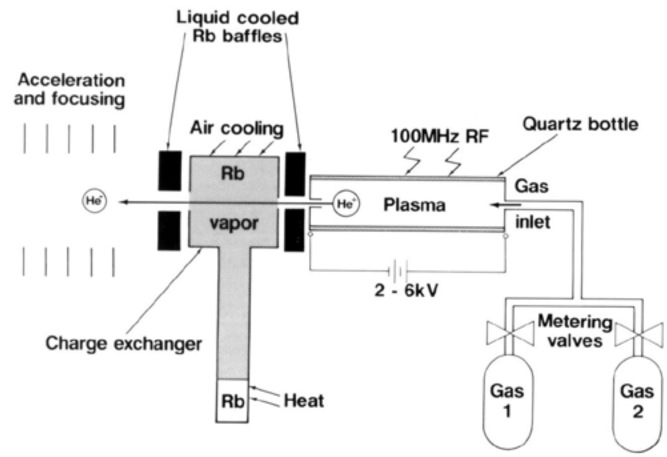
The Alphatross source and oscillator are housed in an RF shielded box. The RF plasma bottle is easily demounted for rapid servicing.

DESIGN

The source is designed for a simple, straightforward operation. The only way that the He^- ion can be formed is by a two-step process that involves the production of the He^+ ion followed by charge exchange using an alkali metal vapor.

Principle of operations: Helium gas (for He^-), hydrogen gas (for H^-), or a gas mixture (for NH^-) is bled into a quartz bottle. An RF oscillator is connected to the quartz bottle to disassociate the neutral gas. The potential difference across the bottle is typically 2-6 kV. The beam exiting the quartz bottle is immediately injected into a rubidium vapor charge exchange cell. Rubidium is chosen because it has a higher charge exchange efficiency than other alkali metals. The rubidium is heated to form a vapor in the beam path. The vapor condenses on the cell walls and returns to the oven for reuse.

The rubidium vapor remains trapped in the charge exchange cells by air cooling to the cell body and liquid cooling to the baffles at the entrance and exit to the charge exchange cell. This ensures a long ion source lifetime. The source uses a quartz bottle to allow for strong plasma. The quartz bottle can be cleaned and reused and is designed with an o-ring seal to allow for quick changes. The entire source is housed in an RF sealed enclosure to protect nearby electronics.



PERFORMANCE

All elements that can exist in the gaseous form and form negative ions (either atomic or molecular) could be considered candidates for ion production in the Alphatross source. The below table shows demonstrated beam currents with various gas mixtures.

Beam emittance of about 1.2 πmm mR (MeV)1/2 for 80% of the He^- beam has been reported. For H^- beam, a 3 πmm mR (MeV)1/2 emittance has been reported[1].

Though source lifetime is dependent on ion species mass, the Alphatross has a proven run time of over 1,000 hours between maintenance. Heavier ions will sputter away the canal faster than light ions and therefore may cause shorter lifetime.

Beam Current	Gas
2-3µA He^-	Helium
>10µA H^-	Hydrogen
> 10µA O^-	He and O_2 controlled independently
2-3µA NH^-	H_2 and N_2 controlled independently
1-2µA NH^-	99% H_2 + 1% N_2 premixed
1µA He^-	99% He + 1% H_2 premixed
2µA H^-	

OPTIONS AND ACCESSORIES

A typical NEC Alphatross system includes the source, a gap/einzel lens, cooling systems, a source gas unit, and power supplies.

Cooling systems: A liquid cooling system is required, and a separate simple air-cooling system is highly recommended, to achieve the necessary temperature and flow rate needed for optimum source life.

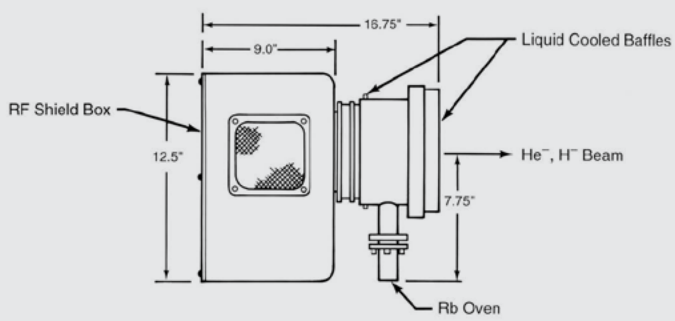
Source gas unit: Source gas bottle assemblies with mass flow controllers are available in single, double, and triple unit sizes. Double or triple unit assemblies are recommended when a gas mixture is required. Separate source gas metering units allow the precise mixing of the gases in the RF plasma.

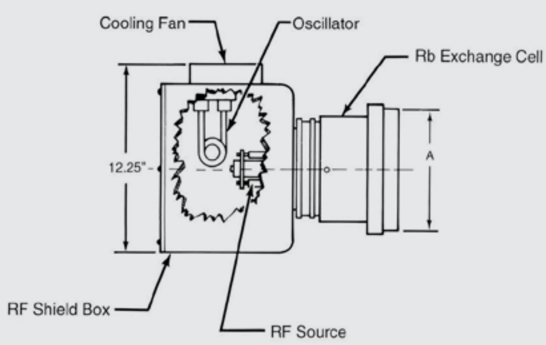
Power supplies: The power supplies are typically provided in an insulated cabinet to allow operation at source potential.

[1]J.R. Tesmer, C.J. Maggiore and D.M. Parkin, Nucl. Instr. and Meth. B40/41 (1989) 718.

J.R. Tesmer, C.R. Evans and M.G. Hollander, proceeding of the

Symposium of Northeastern Accelerator Personnel, (1987), World Scientific, 77.





Exit Flanges Available (A):

- 8" O.D. NEC
- 8" O.D. ConFlat
- 6" ASA
- Other flanges may be available upon request

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