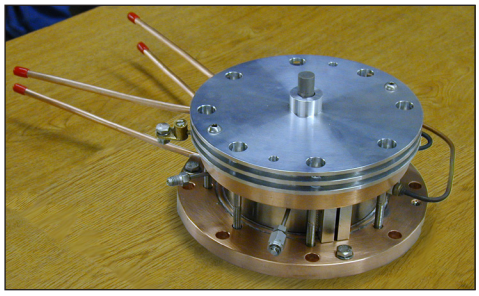
National Electrostatics Corp.
7540 Graber Rd., P.O. Box 620310, Middleton, WI 53562-0310 USA

02/17

Toroidal Volume Ion Source (TORVIS)



The NEC Toroidal Volume Ion Source (TORVIS) is a high current H/He ion source with a toroidal discharge chamber. Negative protons are directly extracted from the source. For negative helium production, a rubidium vapor charge exchange cell is used. The TORVIS is a DC version of the pulsed volume ion source developed at Brookhaven National Laboratories by Prelec and Alessi. This source is designed for efficient injection into tandem electrostatic ion beam Pelletron® accelerators. The TORVIS is a stable, easy to operate ion source and works well over a wide range of conditions.

DESIGN

The TORVIS is a compact vacuum chamber that is completely surrounded by small permanent magnets arranged to create a surface of magnet cusps. These cusps serve to mirror the ions and electrons away from the walls of the chamber. In addition, it incorporates a conical magnetic filter to separate the plasma into two distinct regions.

In the outer toroidal region, the hydrogen discharge produces highly vibrationally excited hydrogen molecules. This process requires fast electrons that are abundant in the outer region of the source. The axial region of the source is separated from the outer region by a conical magnetic dipole field. This field prevents fast electrons from destroying the H^- ions, which are formed in the axial region by the dissociative attachment of excited H^2 with slow electrons.

For negative ion operation, a central magnet is placed on the back plate of the ion source directly opposite the beam exit aperture. This produces a conical region containing slow electrons. The fast electrons are filtered out of this volume, reducing destruction of the negative ion.

For positive ion operation, the central magnet is not used, which allows the faster electrons to depress the formation of a negative ion.

PERFORMANCE

The result is a stable DC beam of 300 to 500 microAmps for H^- (measured after mass analysis). Beam currents (after mass analysis) are routinely measured at 20microA for He^-. See page 3 for further information on performance of the TORVIS source as part of a complete injector system.

The TORVIS source has proven to be very reliable with typical filament lifetimes lasting well beyond 1000 hours.

ACCESSORIES

The TORVIS requires the use of the NEC liquid cooled extractor/lens system for proper focusing of the beam. For proper vacuum pumping, the source requires two (2) turbo pumps attached to the NEC extractor/lens system. NEC can supply the extractor/lens system with pumps as well as necessary power supplies. In addition, NEC can provide a complete TORVIS injector system.

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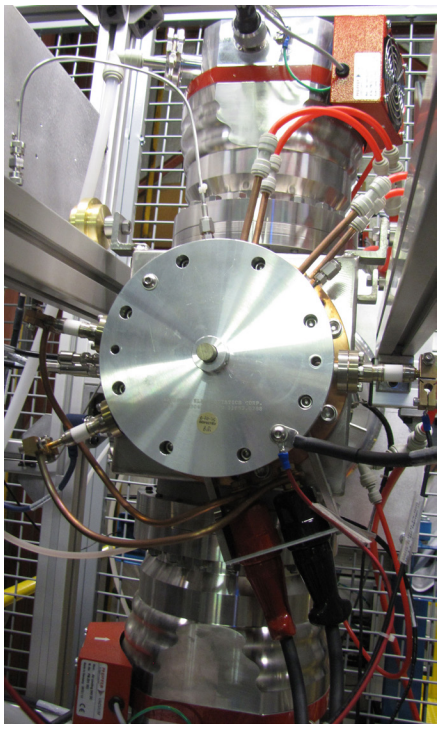
Torodial Volume Ion Source (TORVIS) Injector System



NEC's high current negative light ion injector is designed for use with tandem electrostatic accelerators. Dependent on version, the injector is capable of producing hydrogen (protons), deuterium, and helium ions.

This injector system consists of a NEC Toroidal Volume Ion Source (TORVIS), differentially pumped extractor/gap lens, rubidium vapor charge exchange cell (not used with hydrogen-only version), acceleration tube, Y steerer, Einzel lens, insulating deck, and all necessary power supplies and vacuum equipment.

DESIGN

The TORVIS is a high current light ion source with a toroidal discharge chamber.

The TORVIS is immediately followed by a differentially pumped extraction/gap lens assembly. One turbo molecular pump rated at 700l/s pumps directly on the ion source exit. The second 700l/s turbo molecular pump acts on the gap lens assembly.

Following the extraction/gap lens assembly is a rubidium vapor charge exchange cell (not used with hydrogen-only version). The charge exchange cell has liquid cooled entrance and exit flanges. The body of the cell is maintained at about 50° C to allow the condensation of the rubidium on the interior walls of the cell without freezing out. This allows the rubidium to recirculate through the cell for a lifetime typically longer than 1,000 hours of continuous operation.

The entire extraction/gap lens assembly and source are at injector deck potential and insulated for a rating of more than 20kV from the charge exchange cell. The rubidium charge exchange cell is below deck potential, immediately before the 75kV acceleration tube.

At ground potential, at the exit of the 75kV acceleration tube, is another 700 l/s turbo pump with a Y-steerer and Einzel lens in the pump tee. This pumping arrangement allows for a pressure of about 3 x 10^{-5} Torr at the ion source and about 2-3 x 10^{-6} Torr at the ground pump tee with the source in operation.

OPTIONS

There are three versions of the NEC TORVIS Injector System. The simplest version is optimized for hydrogen isotopes (protons and deuterium) and is a source of negative ions only. In contrast, there is a version optimized for helium and is a source of positive ions only. A charge exchange cell is added to this source to produce the negative helium beam. The third version is capable of producing protons, deuterium, and helium and includes the charge exchange cell.

[TORVIS v1]

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Torodial Volume Ion Source (TORVIS)
Injector System

PERFORMANCE

Injector	Current*
H^- only version	400μA H^- (200μA D)
He^- only version	20μA He^-
H^- and He^- version	100 μA H^-, 20μA He^- (50μA D)

*Measured after mass analysis. Test beam currents are conservative with emittance for efficient transmission through tandem electrostatic accelerator.

SPECIFICATIONS

Facility Requirements

Ion source is at high voltage in open air. Therefore, humidity and dust must be controlled.

Dust: Floors, walls and ceiling should be sealed

Humidity: Dew point not to exceed 15° C

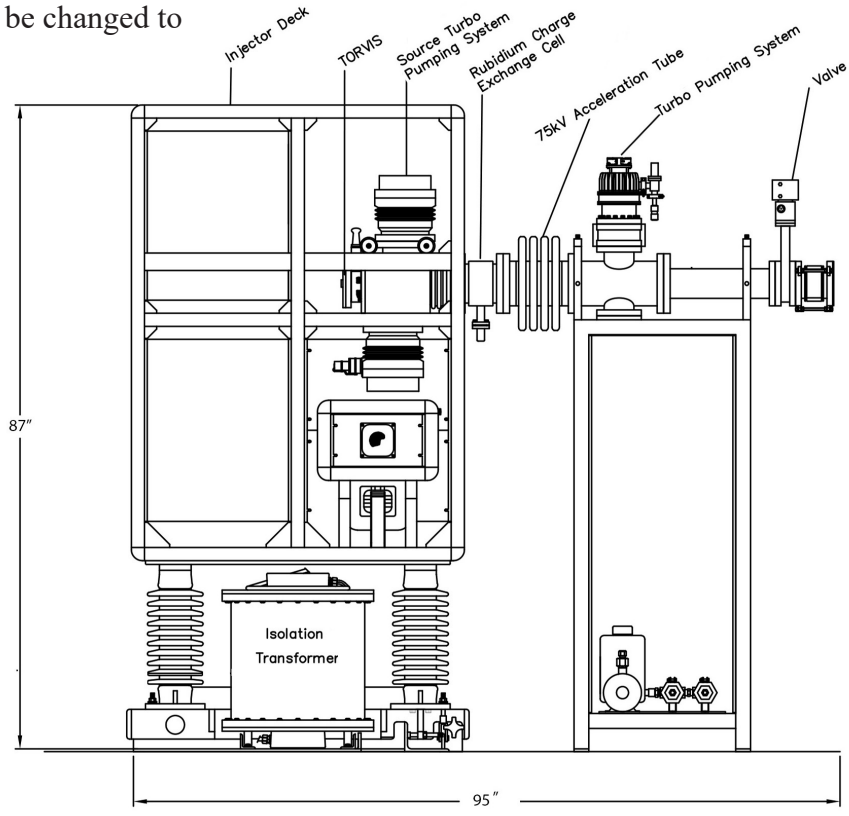
Operating Temperature: 15° C to 25° C

Electrical: 240VAC, 50Hz, 5 wire, neutral grounded, 3 phase (electric power, voltage, and frequency can be changed to match that available at buyer's site)

Water: 15.1 l/m, 20° C or less

Compressed Air: 80 psig (5.7kg/cm^2)

Argon: For source service



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