ION BEAM SOURCES
National Electrostatics Corp.

Source of Negative Ions by Cesium Sputtering - SNICS II

APPLICATIONS

SNICS II is designed as a heavy-ion source and is used in diverse applications, including ion implantation and damage studies. The source, (shown right) with the extractor/lens assembly, generates ion beams by accelerating cesium ions onto a sample target (cathode), which sputters out negative particles from the sample. There are now over 100 SNICS II ion sources in use on Pelletron® accelerators and other tandem accelerators throughout the world. The unique design of NEC's SNICS II – including a metal/ceramic construction with no organic seals in the main housing of the source – has produced a reliable system with superior performance. The SNICS II sputter cathode source is the most versatile negative ion source presently available, producing ion beams for all elements that form a stable negative ion.

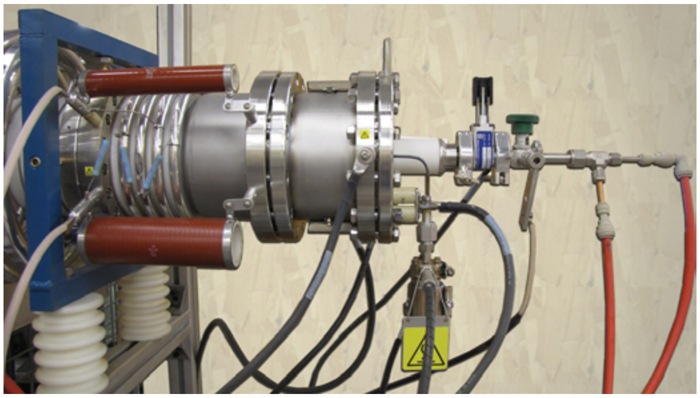
DESIGN

This source was developed by J.H. Billen and H.T. Richards at the University of Wisconsin and independently, by R. Middleton at the University of Pennsylvania. The SNICS II has multiple design considerations that allow it to maximize beam production. The SNICS II has an all-metal sealed main housing. The only o-rings are in the back of the cooled area on the cathode holder. This arrangement allows the body of the source to remain warm relative to the cathode. The volume around the ionizer and cathode is fully enclosed, which keeps the cesium vapor in the volume. Provisions are available to adjust the cathode insertion position while the source is running, optimizing beam current. Adjusting the cathode position can also allow longer runs on a single cathode by optimizing the amount of material used per run.

OPTIONS

NEC offers a gas cathode assembly which allows the insertion of gas through the center of a cathode. Cathode liquid cooling systems and all necessary power supplies are also available from NEC.

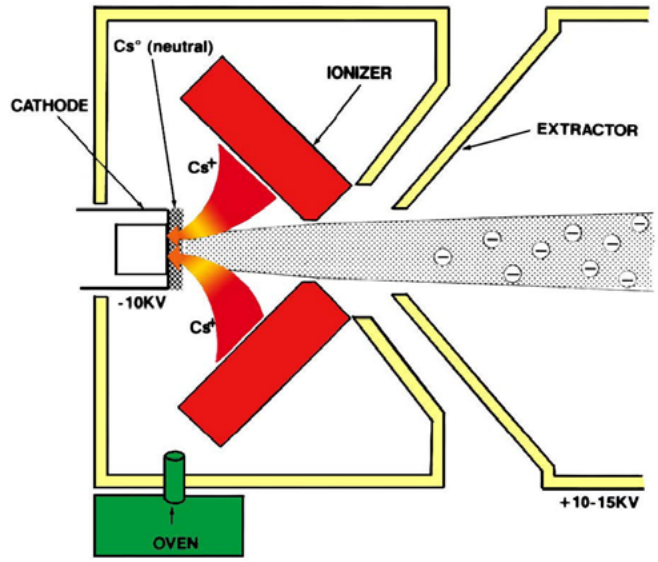
Recommended Power Supplies		
Cs Ionizer	10 V, 35 A	Current regulated
Cathode Bias	-10 kV, 7.5 mA	Voltage regulated
Extractor	15 kV, 5 mA	Voltage regulated
Focus	15 kV, 5 mA	Voltage regulated
Cs Oven	60 V, 6 A	Voltage regulated
Line Heater	10 V, 70 A	Current regulated



SNICS II source with extractor

HOW IT WORKS

Cesium vapor flows from the cesium oven into an enclosed area between the cooled cathode and the heated ionizing surface. Most of the cesium is ionized by the hot surface, while some of the cesium condenses on the front of the cathode. The ionized cesium sputters particles from the cathode through a condensed cesium layer on the cathode face. Negative ions are propelled near the cathode surface and then accelerated back toward the ionizer.



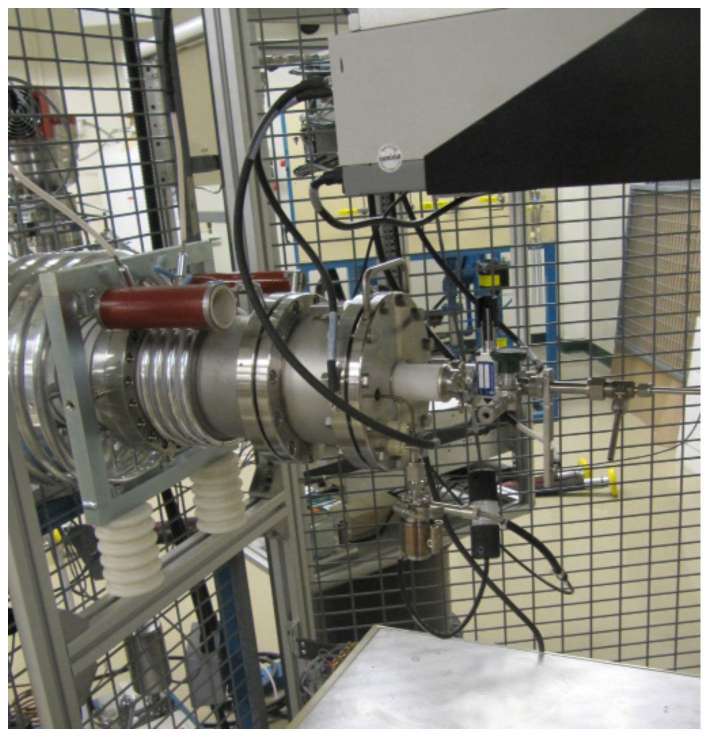
PERFORMANCE

NEC maintains an ongoing research program to continuously improve the performance of the SNICS II source and to develop new ion beams. A list of negative ion beams that have been produced by NEC and other laboratories using the SNICS II source follows on page 4. Cathodes for many of these ion beams are available from NEC. Other cathodes may be available upon request.

The ion beam emittance of the SNICS II ion source is a factor of 2 to 4 times better than that from the older style sputter cone sources. Customers report* emittances of the resulting negative ion beam from 5 to less than 3 πmm mR $(MeV)^{1/2}$ for 80% of the beam, depending upon the beam mass.

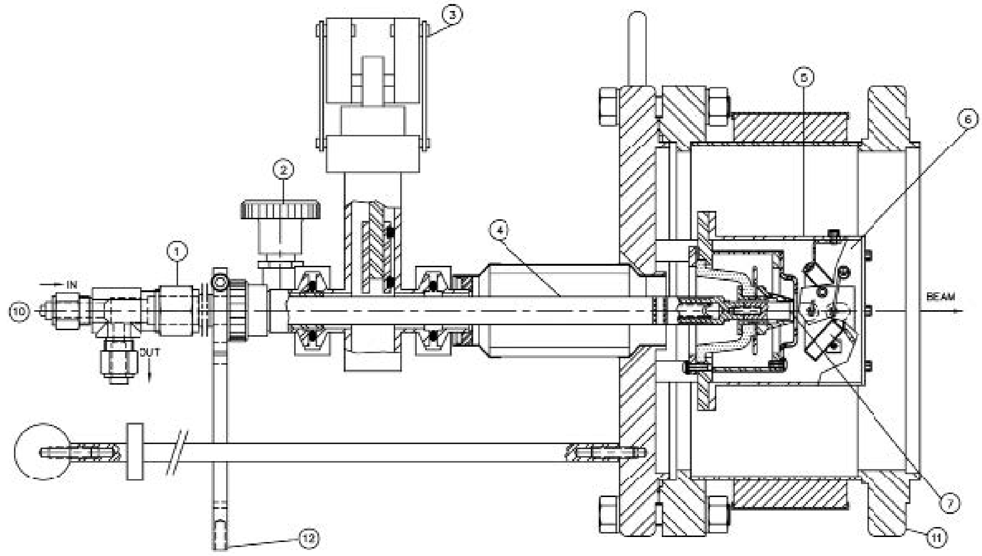
The maintenance period of the SNICS II is dependent on beam type and beam current produced. However, customers reported 3-6 months between source maintenance, except for cathode change. This translates into well over 1000 hours of beam production time. The lifetime of a cathode is highly dependent on the sputter rates. However, the source is designed to allow the change of a cathode without turning the source off. In Pelletron® systems, it is common to change a cathode within 10 minutes from beam on target to beam on target.

** Nucl. Instr. & Meth. B40/41 (1989) 718*

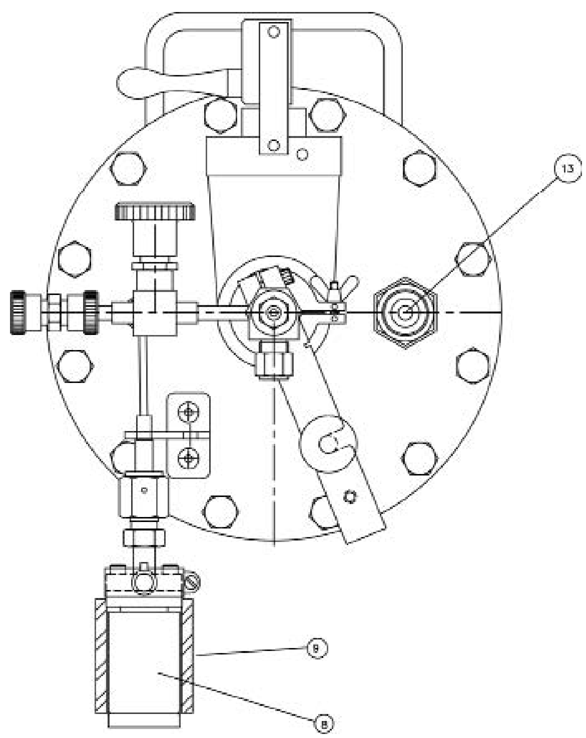


SNICS II injector for a 3MV tandem Pelletron

Side View



Front View



1. Heat exchanger
2. Roughout port
3. Valve
4. Cathode holder
5. Ionizer chamber
6. Ionizer
7. Cathode
8. Cesium oven reservoir
9. Heater band
10. Cooling input/output
11. Source ground
12. Cathode voltage
13. Ionizer current

Typical Ion Beam Currents

Negative Ion	Current after Analysis (µA)	Negative Ion	Current after Analysis (µA)
H^-	130	As^-	60
D^-	150	Se^-	10
Li^-	4	Br^-	40
BeO^-	10	Sr^-	1.5
B^-	60	Y^-	0.66
B_2^-	73	Zr^-	9.4
C^-	260	Nb^-	7
C_2^-	40	Mo^-	5
CN^-	12	Rh^-	5
$CN^-(^{15}N)$	20	Ag^-	13
O^-	300	CdO^-	7
F^-	100	InO^-	20
Na^-	4.0	Sn^-	20
MgH_2^-	1.5	Sb^-	16
Al^-	7	Te^-	20
Al_2^-	50	I^-	220
Si^-	430	Cs^-	1.5
P^-	125	CeO^-	0.2
S^-	100	NdO^-	0.3
Cl^-	100	EuO^-	1.0
CaH_3^-	0.8	ErO^-	10
TiH^-	10	TmO^-	1.0
VH^-	25	YbO^-	1.0
Cr^-	5	Ta^-	9.5
MnO^-	4	TaO^-	6
Fe^-	20	W^-	2.5
Co^-	120	Os^-	15
Ni^-	80	Ir^-	100
Cu^-	160	Pt^-	250
ZnO^-	12	Au^-	150
GaO^-	7	PbO^-	1
Ge^-	60	Bi^-	3.5

This list is based on data from AT&T Bell Laboratories, the NEC test bench and other contributing laboratories. All ion beam currents listed are measured after 30° or 45° mass analysis.

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