

Source of Negative Ions by Cesium Sputtering - SNICS II

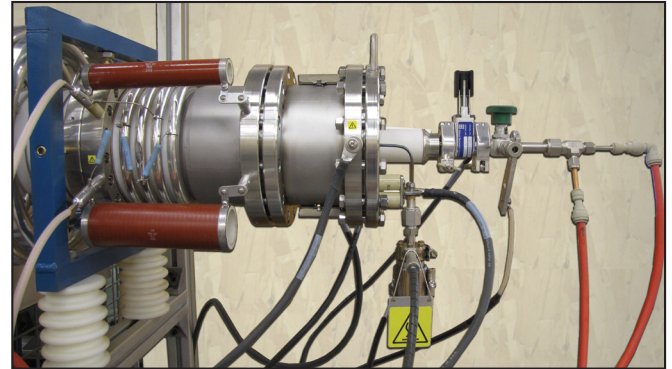
APPLICATIONS

The SNICS II ion source is the most versatile negative ion source presently available. The source, (shown right) with the extractor/lens assembly, will produce ion beams for all elements which form a stable negative ion. There are now over 100 SNICS II ion sources in use on Pelletron® accelerators and other tandem accelerators throughout the world. Its unique design and metal/ceramic construction with no organic seals in the main housing of the source have produced a system with superior performance for all negative ions across the periodic table.

DESIGN

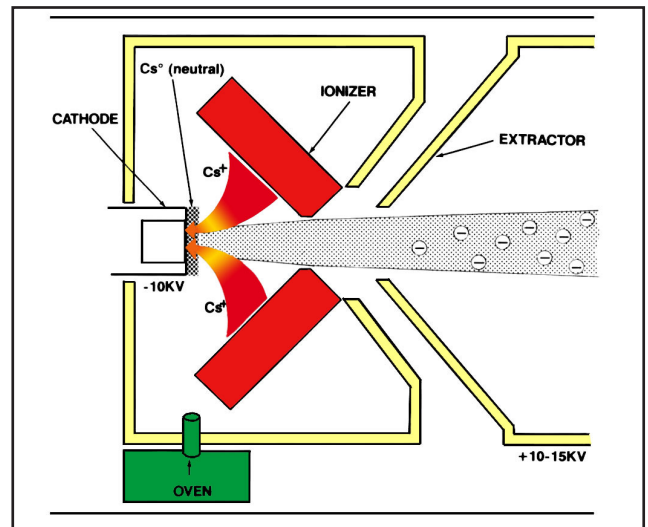
This source was developed by J.H. Billen and H.T. Richards at the University of Wisconsin and independently, by R. Middleton at the University of Pennsylvania. The source design has been modified by NEC to increase performance and reliability.

Principle of operation: Cesium vapor flows from the cesium oven into an enclosed area between the cooled cathode and the heated ionizing surface. When vapor atoms condense onto this heated surface, they become positive cesium ions, which are then accelerated and focused onto the front face of the cathode. The ionized cesium sputters particles from the cathode through a condensed cesium layer on the cathode face. The low electron affinity of the cesium favors the production of negative ions in the sputtering process, and those ions are accelerated back toward the ionizer, and focused into a negative ion beam.



SNICS II source with extractor

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. In addition, the volume around the ionizer and cathode is fully enclosed. These design considerations keep the cesium vapor in the volume required for maximum beam production.



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The SNICS II is equipped with a valve on the cathode holder assembly. This allows a cathode to be changed without disturbing the source vacuum. Only the bias voltages need to be turned off.

Cesium Oven:

The cesium oven allows the insertion of the complete Cs glass ampule. The glass ampule is broken as the oven is tightened, eliminating the need to use an argon enclosure to fill the cesium oven.

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. 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 $3 \pi \text{mm mradMeV}^{1/2}$ for 80% of the beam, depending upon the beam mass.

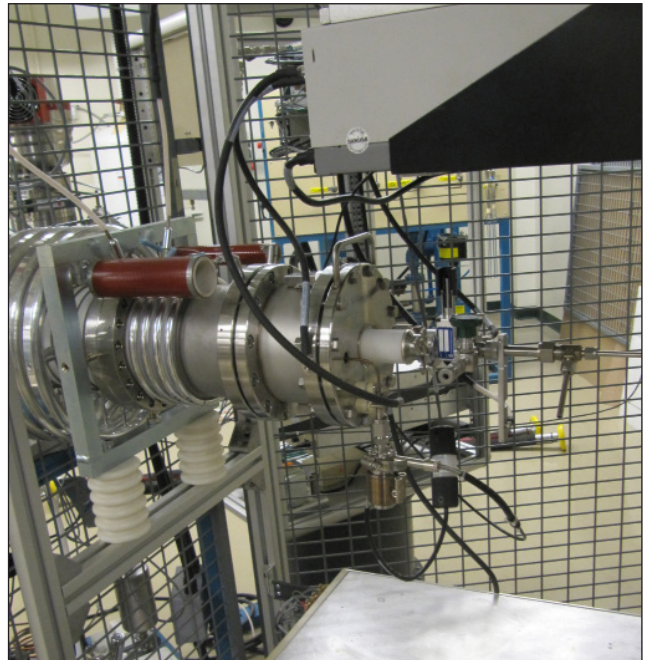
The lifetime of the SNICS II is dependent on beam type and beam current produced. However, customers reported 3-6 months between source maintenance, except for cathode change. This translates into well over 1000 hours of beam production time. The lifetime of a cathode is highly dependent on the sputter 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

OPTIONS AND ACCESSORIES

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



SNICS II injector for a 3MV tandem Pelletron



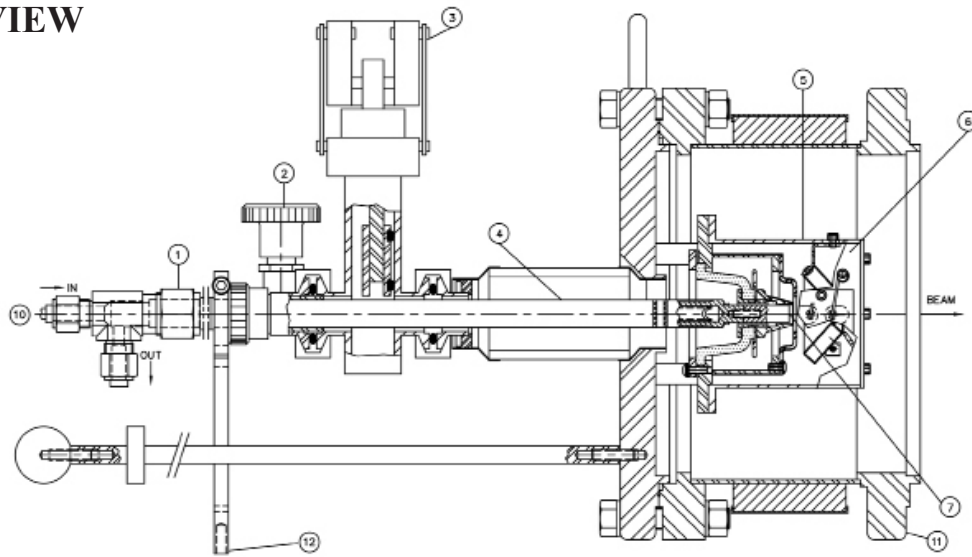
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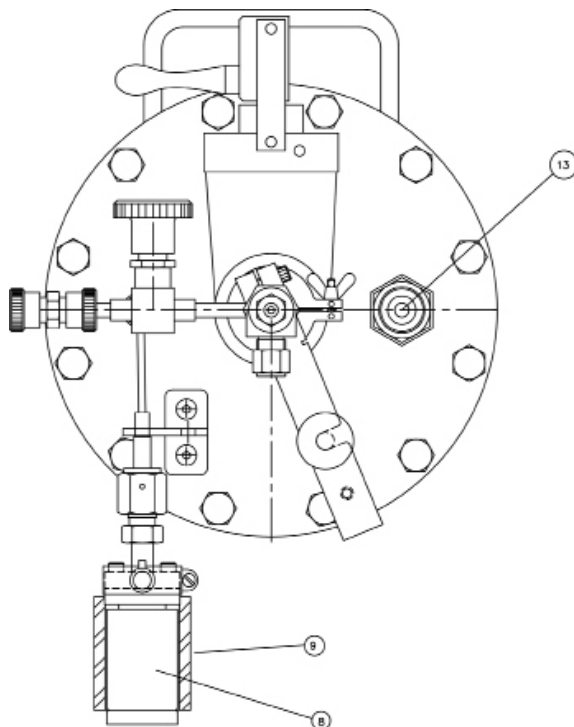
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SIDE VIEW



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

Negative Ion Beams Produced by SNICS II

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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