Tests of a new Axial Sputtering Technique in an ECRIS

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ABSTRACT

Axial and radial sputtering techniques have been used over the years to create beams from an ECRIS at multiple accelerator facilities. Operational experience has shown greater beam production when using the radial sputtering method versus axial sputtering. At Argonne National Laboratory, previous work with radial sputtering has demonstrated that the position of the sputter sample relative to the plasma chamber wall influences sample drain current, beam production and charge state distribution. The possibility of the chamber wall acting as a ground plane which influences the sputtering of material has been considered, and an attempt has been made to mimic this possible ground plane effect with a coaxial sample introduced from the injection end. Results of these tests will be shown as well as comparisons of outputs using the two methods.
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TITANIUM RESULTS

Technique	48/13+ (μA)	sputter V (kV)	sputter I (mA)	sp power (W)	use rate* (mg/hr)	14 GHz (W)	Ext I (mA)	C1 (A)	C2(A)	V1(Torr)
Radial	2.2	0.51	0.46	0.23	.03	350	2	501	514	2.70E-07
Axial bare	2.2	3.1	1.1	3.41	.81	350	1.8	522	483	2.20E-07
Axial w/sleeve	2.2	6.5	0.55	3.58	.22	352	2.5	455	476	2.30E-07

*Use rate is for ~1μA averaged over a few days

Technique	48/14+ (μA)	48/13+ (μA)	48/11+ (μA)	27/7+ (μA)
Radial	0.91	1.63	0.95	0.22
Axial bare	1.1	1.6	~0.7	0.67
Axial w/sleeve	0.93	1.7	~1	1

Technique	Maximum 48/13+ achieved (μA)
Radial	16
Axial bare	5
Axial w/sleeve	2.2

SILVER RESULTS

Technique	107/21+ (μA)	sputter V (kV)	sputter I (mA)	sp power (W)	use rate (mg/hr)	14 GHz (W)	Ext I (mA)	C1 (A)	C2(A)	V1(Torr)
Radial	18.3	0.58	0.43	0.25	1.7	280	1.91	528	519	1.80E-07
Axial bare	18.1	2.7	0.46	1.24	4.2	249	1.5	494	490	1.90E-07
Axial w/sleeve	18.1	3.7	0.1	0.37	-----	245	1.45	495	490	2.10E-07

*Use rate is for ~16 μA averaged over a few days

Technique	107/23+ (μA)	107/22+ (μA)	107/21+ (μA)	107/19+ (μA)	27/7+ (μA)
Radial	4.1	9.1	17.4	48.5	-----
Axial bare	5.2	10.8	18.3	30	.13
Axial w/sleeve	6.3	11.1	17.9	25.5	.16

Technique	Maximum 107/21+ achieved (μA)
Radial	27 **
Axial bare	18.8
Axial w/sleeve	18.1

** Sputter not pushed for fear of melting sample

AXIAL POSITION DEPENDANCE

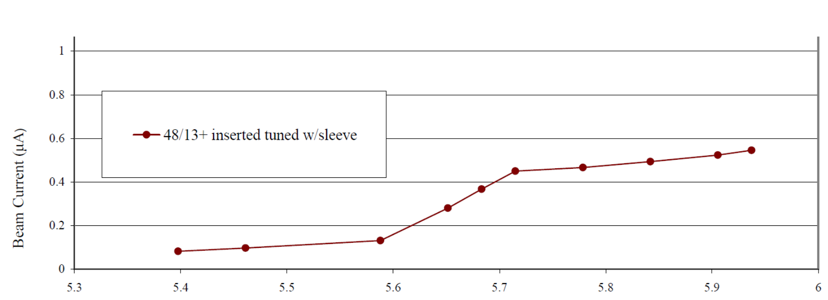
Maximum measured beam current was at furthest insertion point allowed by the axial feed-thru and initial position. This result was true for both materials tested and for all axial methods of sputtering.

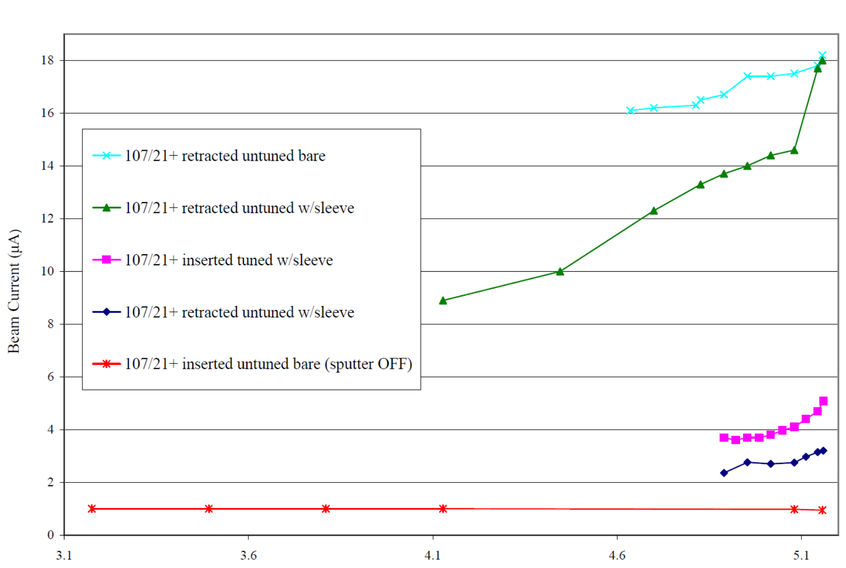
Optimal axial sputtering position is likely closer to the plasma for both axial methods.

Below: Beam Current vs. Distance from Bias Disk. (sputter voltage kept constant)

tuned: gas +solenoids for peak at each location

untuned: position changed only

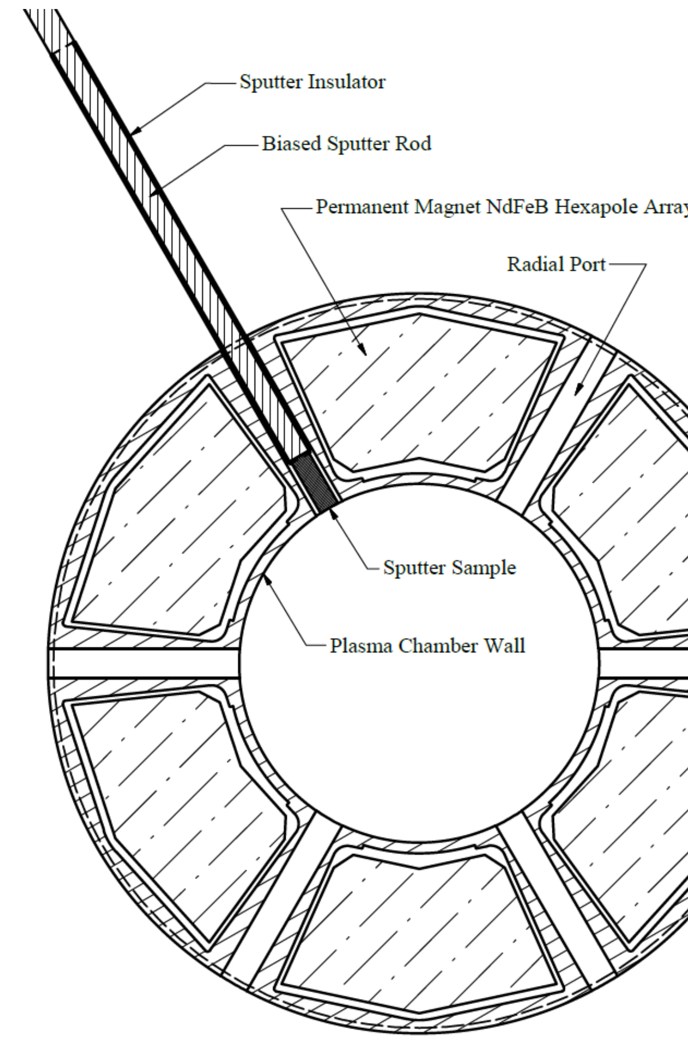




THREE SPUTTERING TECHNIQUES WERE COMPARED UNDER SIMILAR CONDITIONS

Efforts were made to provide consistency of measurements:

- Same negative bias power supply was used for repeatable voltage and current measurements.
- Single frequency (~14GHz) RF input at prescribed power levels
- Similar source bake out conditions
- Oxygen support with no additional gas mixing
- Grounded bias disk
- Same sample shapes and sizes for specific materials



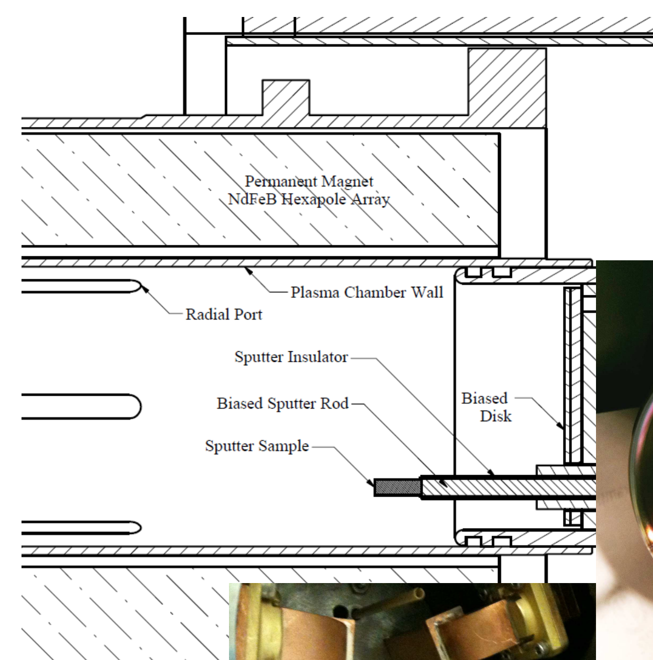
RADIAL INSERTION

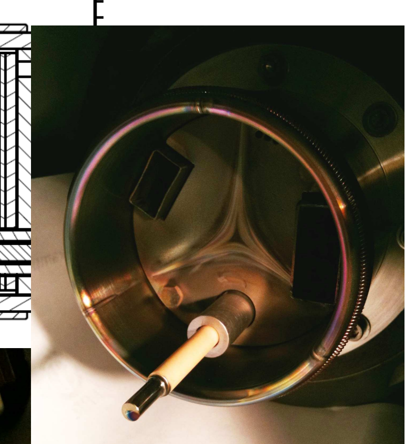
Optimal radial position is known for ECR2 and was fixed for these tests.

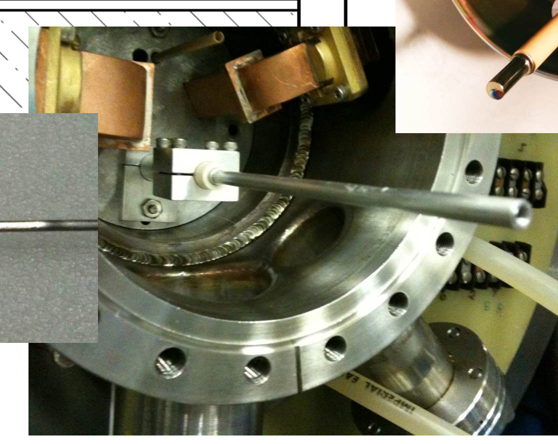
AXIAL INSERTION

Optimal axial position was not known for ECR2.

- Biased rod was inserted with a linear motion feed-thru to determine best location.
- Max measured beam I at furthest insertion point allowed by feed-thru and set-up conditions.
- Ground sleeve was fixed in retracted position.







AXIAL INSERTION WITH CO-AXIAL GROUNDED SLEEVE

- Same insertion point as standard axial for specific materials
- Ground sleeve travels with sample
- Sample face is co-planar with sleeve face