

thin film components | better magnetic design | integrated solutions | OEM support | process specific

gencoa: perfect your process

intelligent plasma monitoring and feedback



Circular Ion Sources for pre-treatment, etching and ion assistance

Frank Papa*, Dermot Monaghan, Robert Brown, Alex
Azzopardi, Victor Bellido-Gonzalez, Ioritz Sorzabal

*Gencoa, Davis, CA, USA
Gencoa, Liverpool, UK

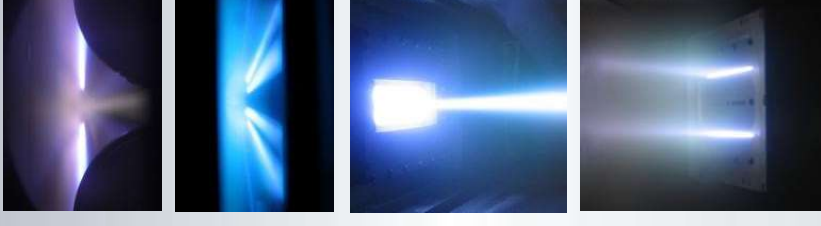
research & development

products. process. support. **gencoa**



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- Introduction
- Ion Source Principles
- IMC75 Principle
- IMC75 Operating Range
- Power Supply/Feedback Control
- Etching Results
- DLC Coating Results
- Summary



Reach your full potential with Gencoa's unique tools

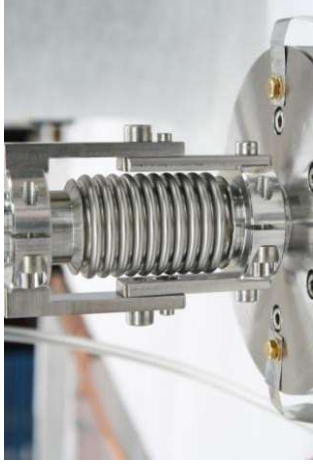
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Genco IM75 plasma source for *Research and Development*

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A multi-functional plasma beam



- A powerful new tool for thin film research.
- Fits into the space of a typical magnetron and has head tilt adjustment.
- Self neutralized plasma - no substrate surface charging.
- Variable plasma energy.
- Automatic gas feedback control via the IM300 power supply (any gas).
- Robust design with no maintenance.
- Can replace RF substrate etching.
- Multiple uses - ion assistance, patterning, pre-cleaning, coating stripping, PECVD



Introduction

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Hall Effect Ion Thrusters

Courtesy of NASA

Ion sources for vacuum applications are a product of Hall Effect Ion Thrusters developed by USSR & USA during the space race of the 1950s/60s



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Surface Modifications - Nanotexturing



Coating removal



Introduction

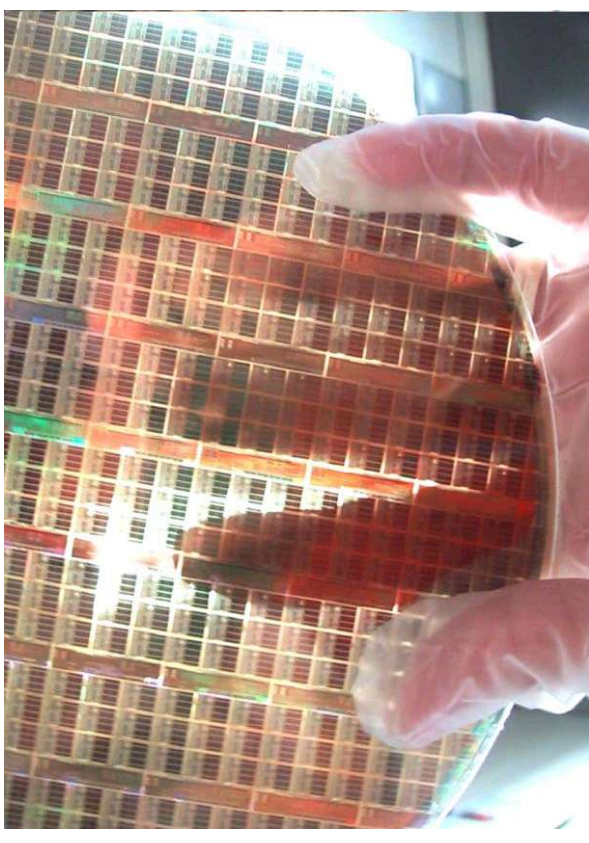
Applications

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Improving Coating Adhesion



Etching prior to deposition on semiconductor applications

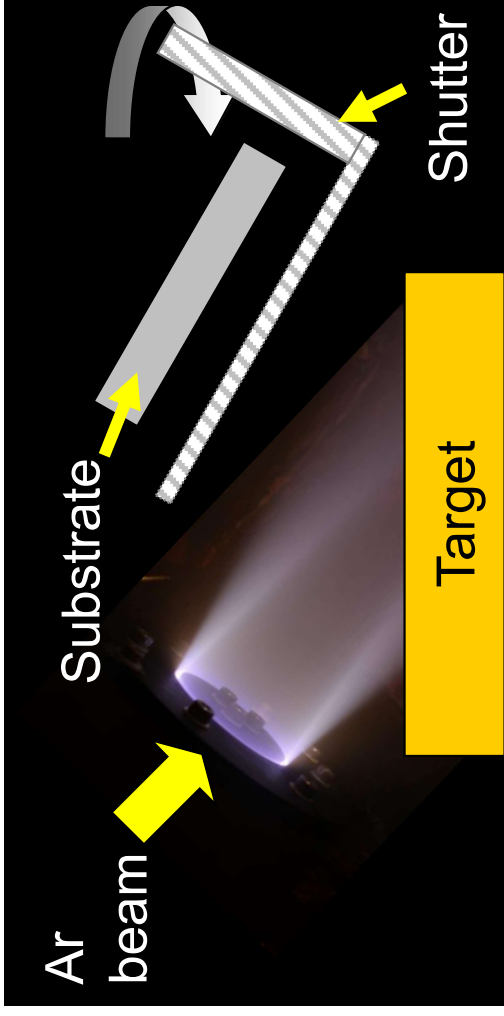


ITO & Silver Deposition Assistance

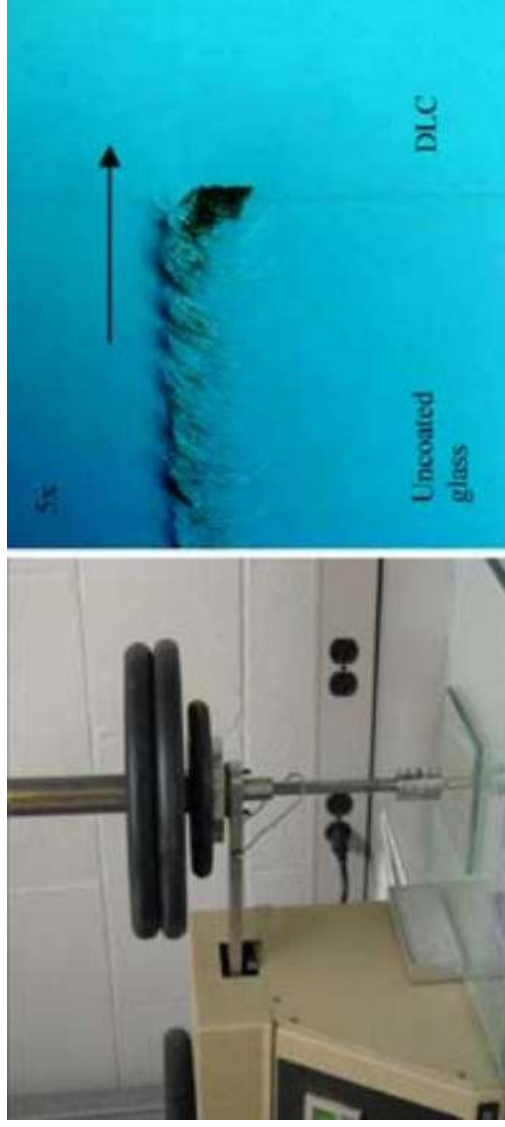


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Ion Beam Deposition (IBD)



Scratch resistance test on uncoated and coated glass



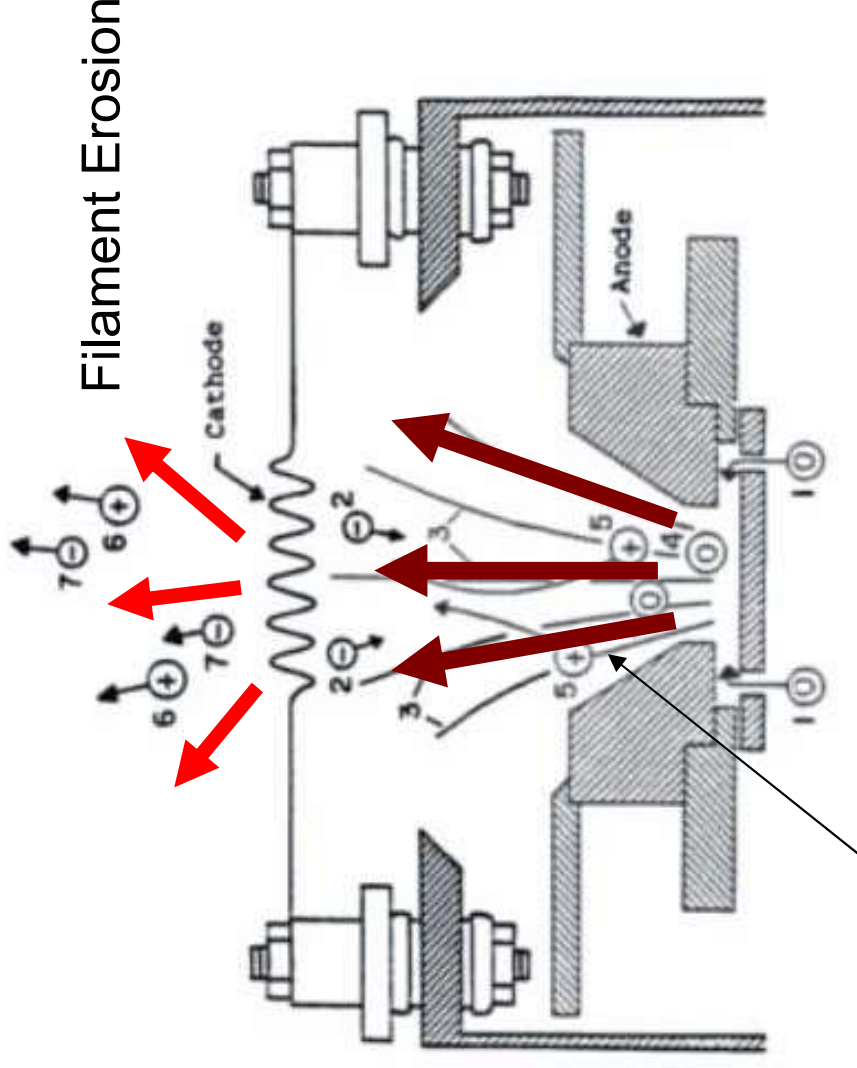
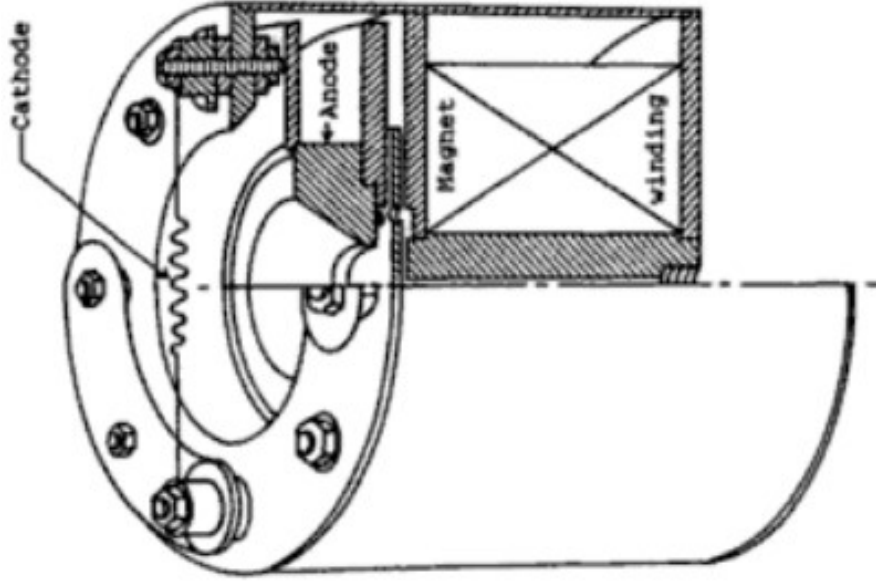
Source:
Guardian Glass
GPD 2009



Ion Source Principles

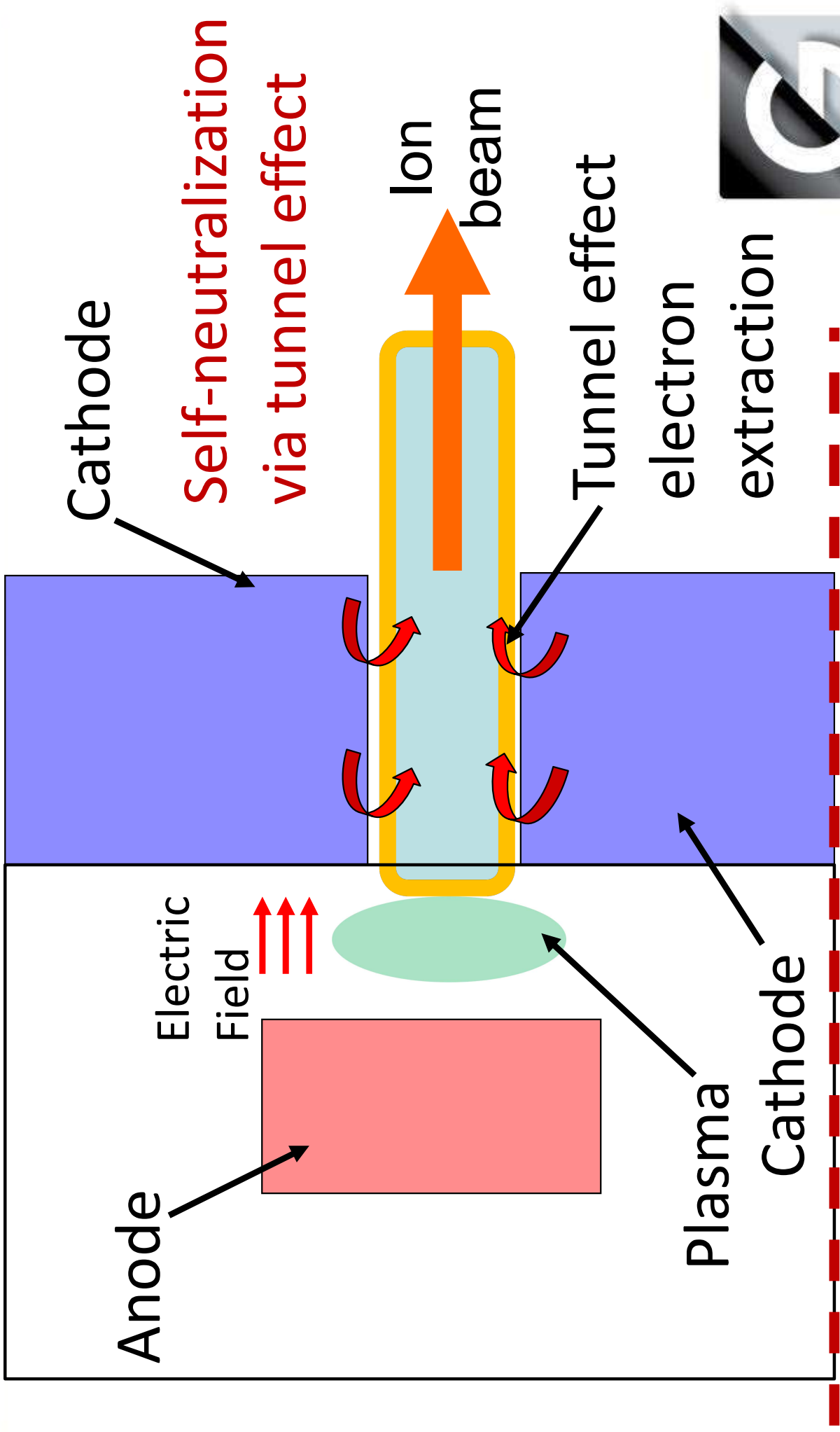
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Types of Ion Beam Sources – Filament Limitations



- Filament erosion leads to sample contamination
- After a limited number of hours the filament needs to be replaced





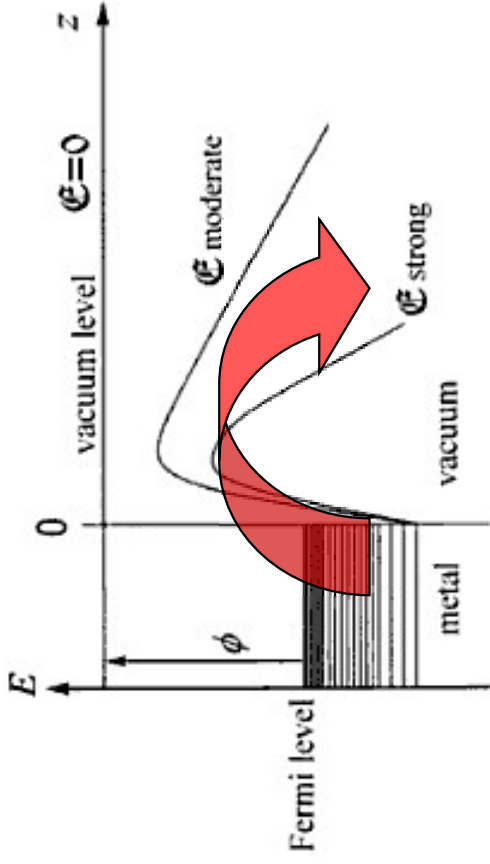


Fig. 3.5. Potential barrier at the surface of a metal: at very high electric field strength, its shape becomes a hill of sufficiently small width through which electrons can tunnel quantum-mechanically

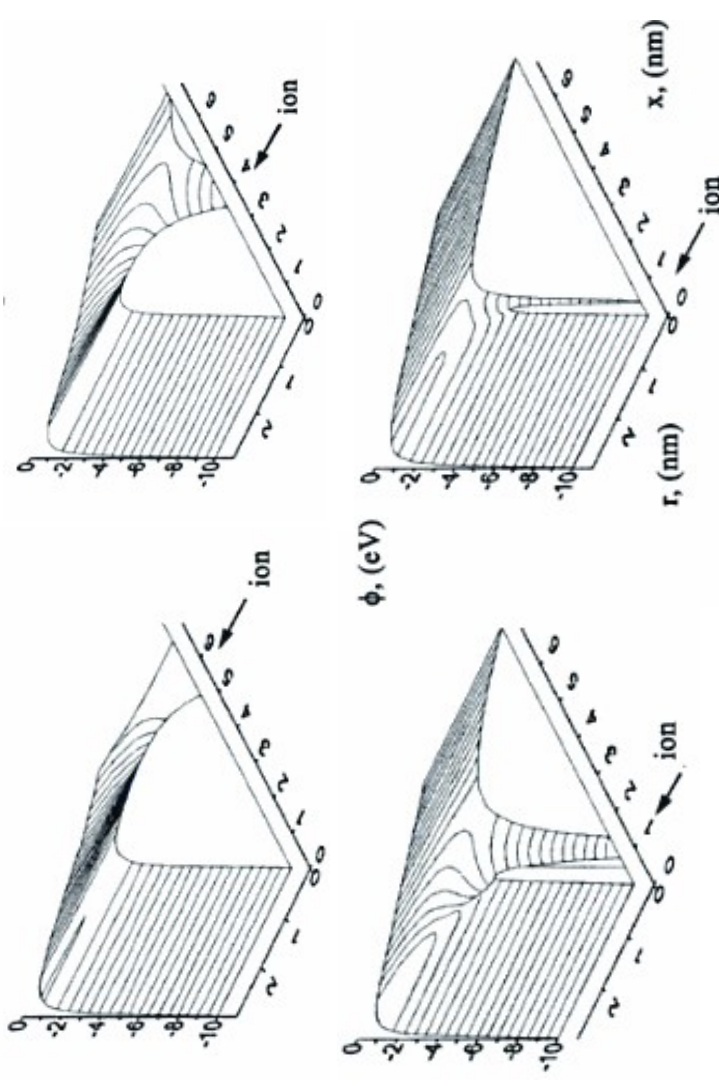


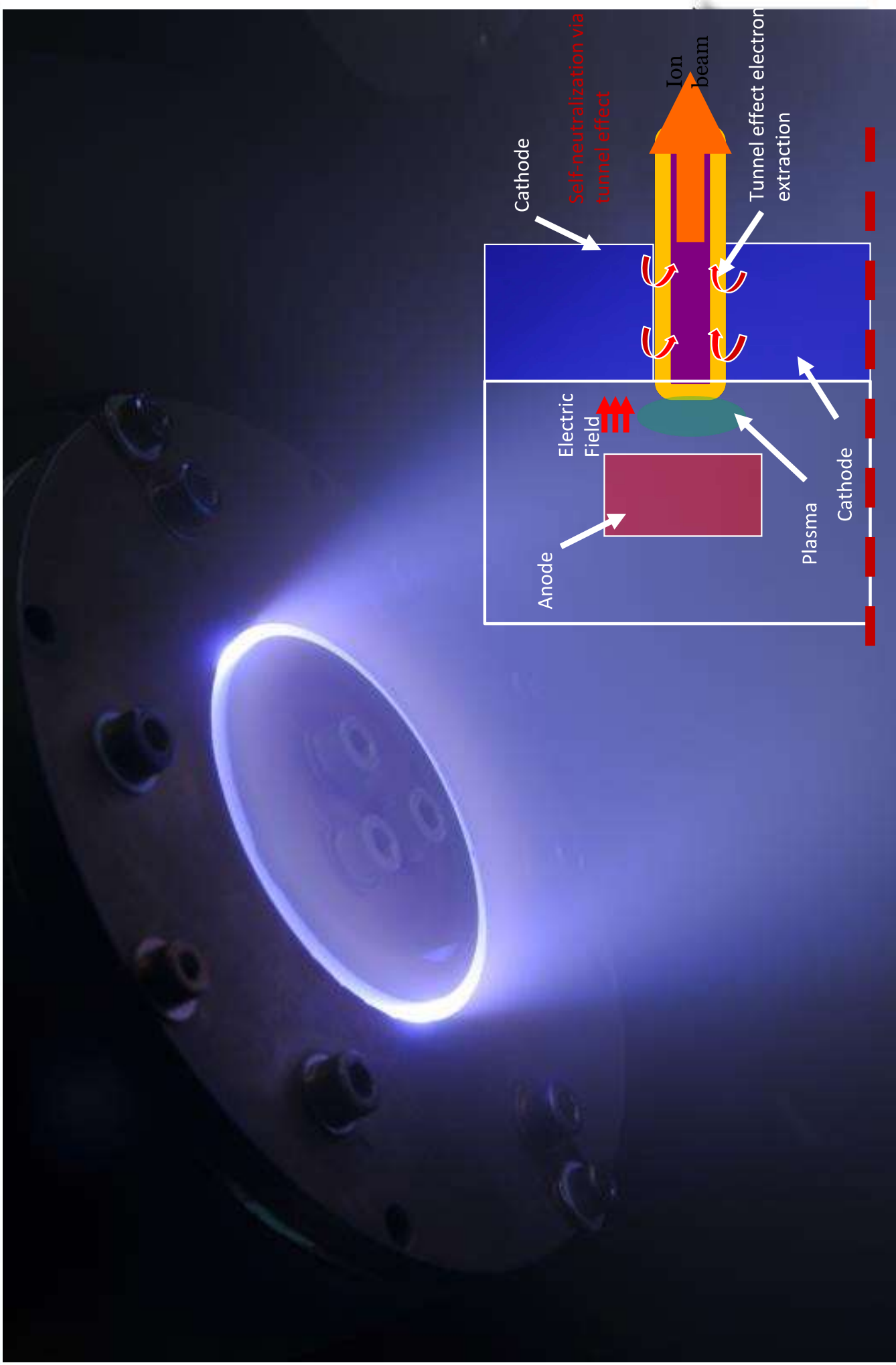
Fig. 3.12. Illustration of the time-dependent potential when an ion approaches a cathode, calculated for a Cu^{2+} ion and an average field of $1.4 \times 10^9 \text{ V/m}$ (adapted from Figure 6 of [31]); x is the distance from the surface, r is the radial distance from the projected impact location. At large distances ($x > 5 \text{ nm}$), the deformation of the potential barrier by the ion is negligible, and at small distances ($x < 0.4 \text{ nm}$), the ion captured one electron

Ions travelling near a cathode would deform the electric field. With a strong deformation electrons would be able to be extracted by tunnel effect.



Genco IMC75 plasma source neutralized beam via tunnel effect electron extraction

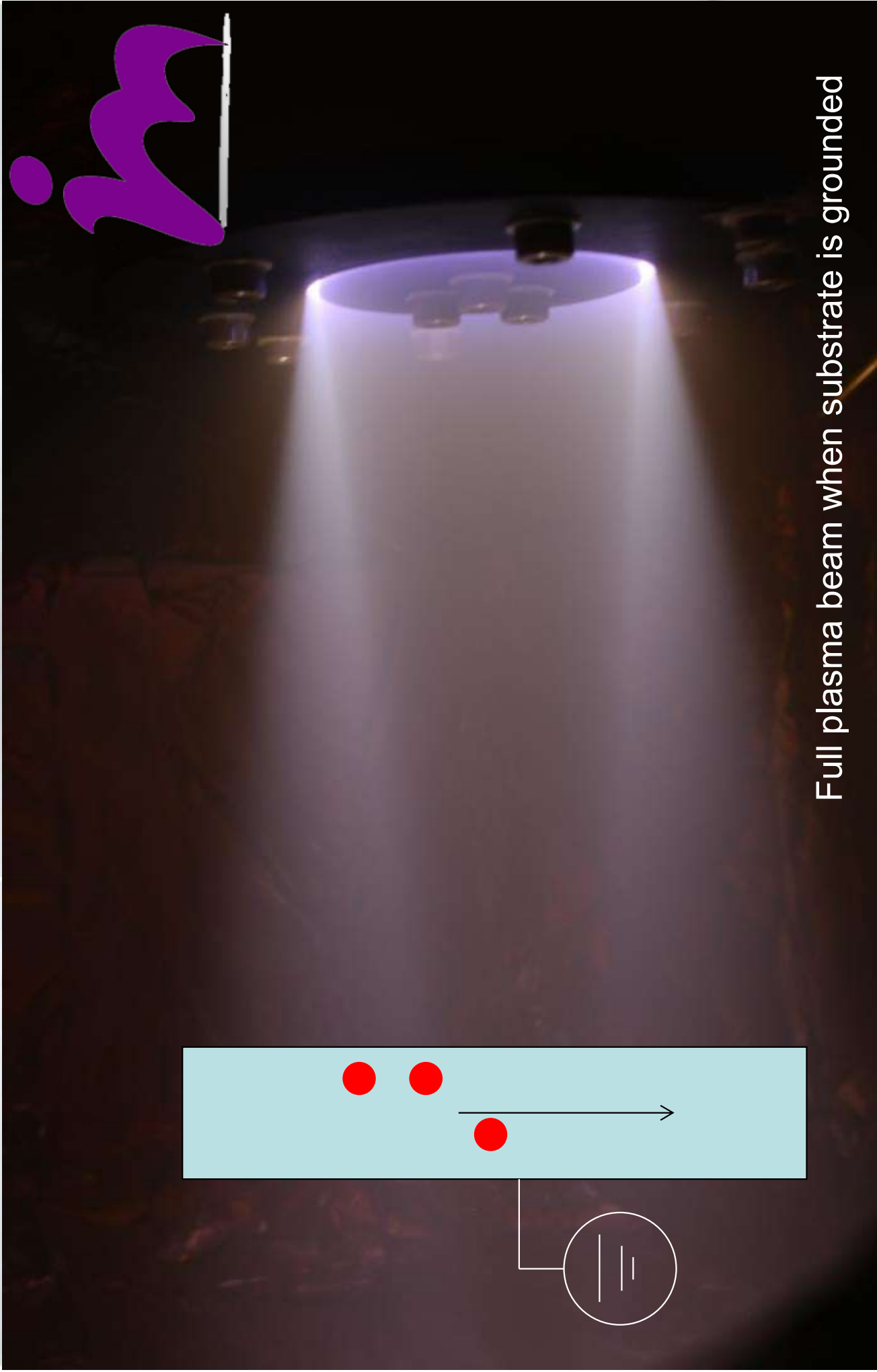
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IMC75 Characterization

IMC75 on Conductive Substrate

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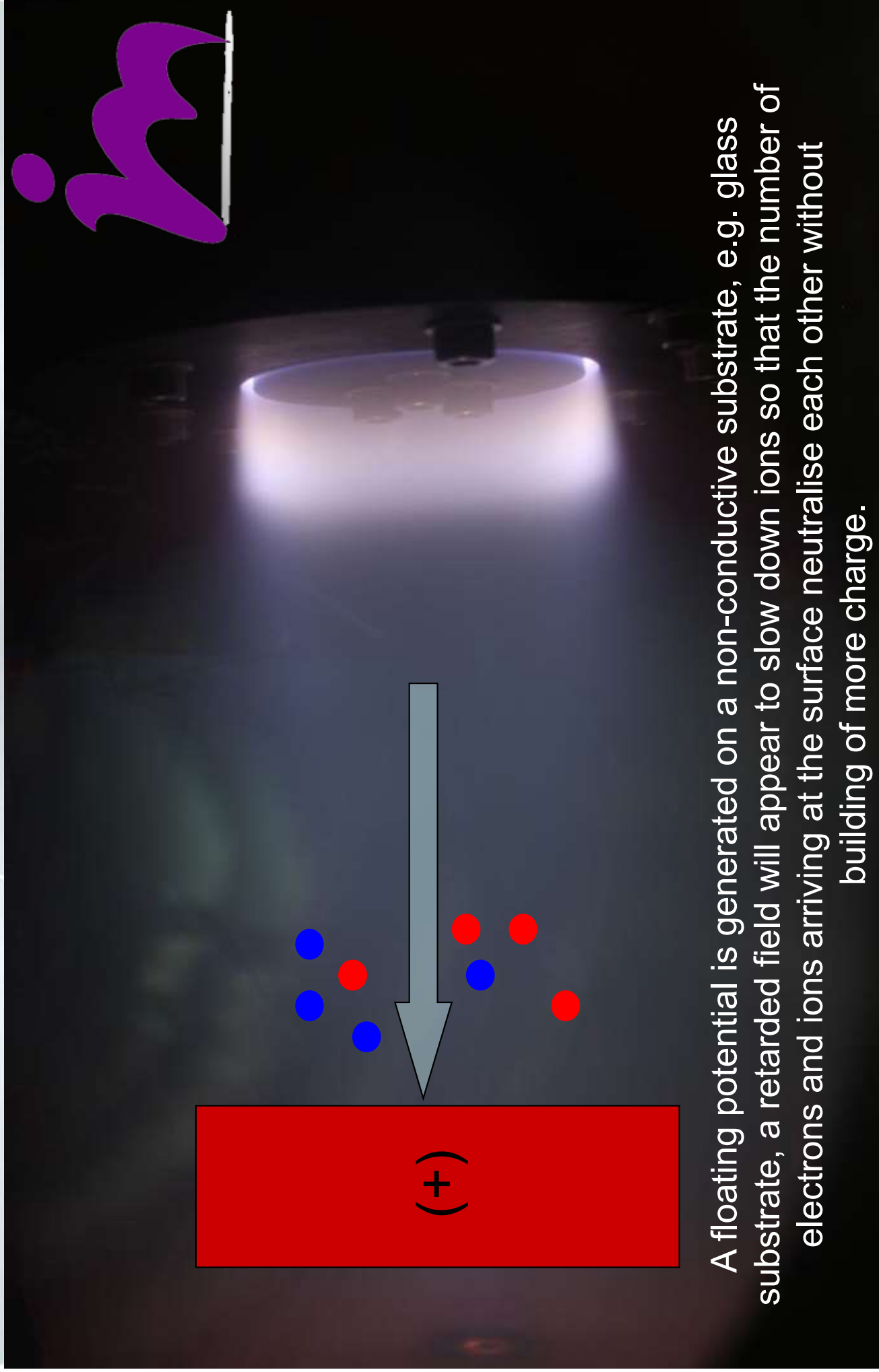


Full plasma beam when substrate is grounded

IMC75 Characterization

IMC75 on an Insulating Substrate

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A floating potential is generated on a non-conductive substrate, e.g. glass substrate, a retarded field will appear to slow down ions so that the number of electrons and ions arriving at the surface neutralise each other without building of more charge.

IMC75 Characterization

IM75 on an Insulating Substrate

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This type of ion source is specially suited for complex substrate as it will automatically adapt to the substrate electrical nature

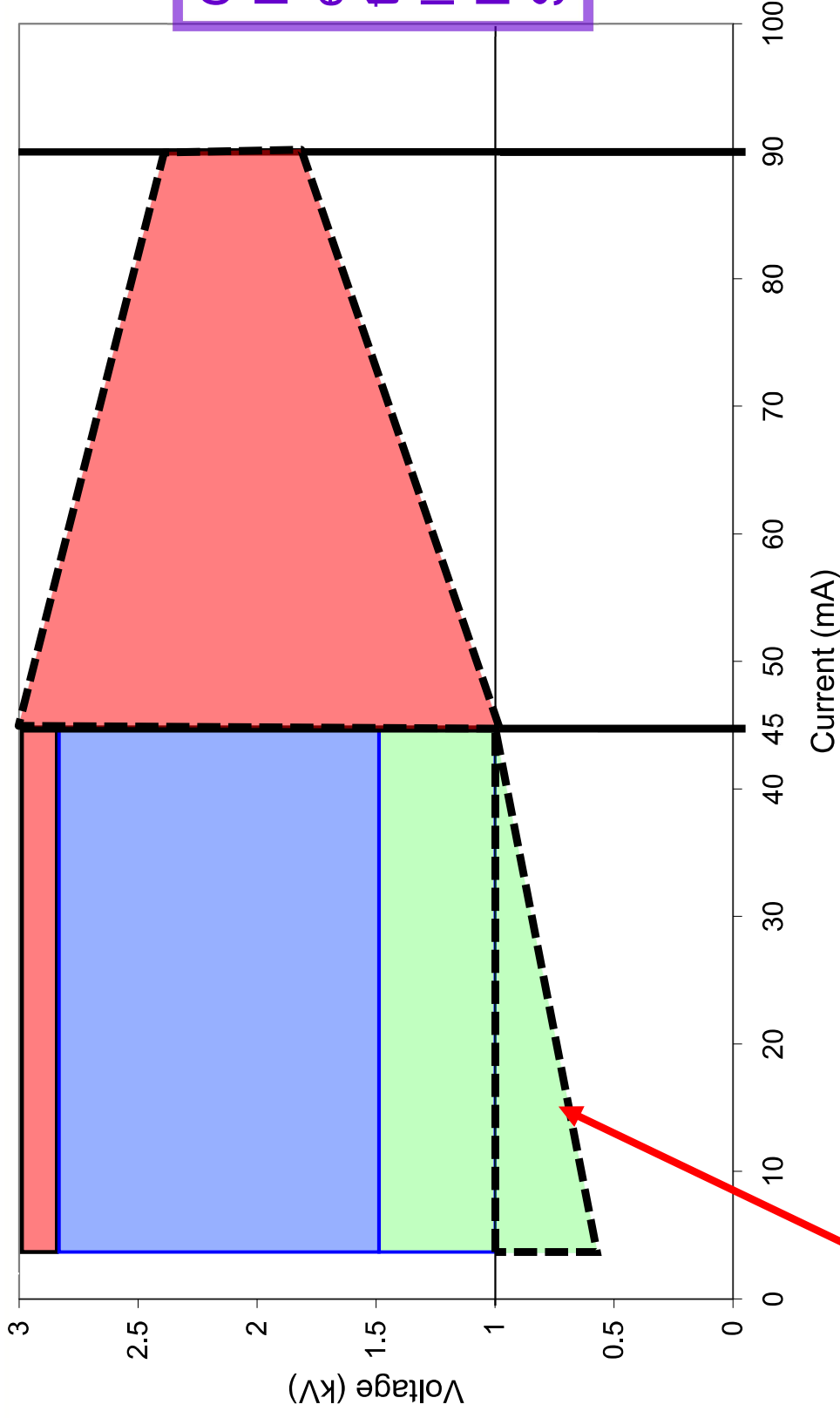


IM75 self-neutralisation

IMC75 Characterization

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Operation Range for IMC75 Ion Source



Operation Range equivalent to industrial large area Linear Ion Sources.

- Normal operation area
- Extended operation area
- Low energy area
- Very Low energy area

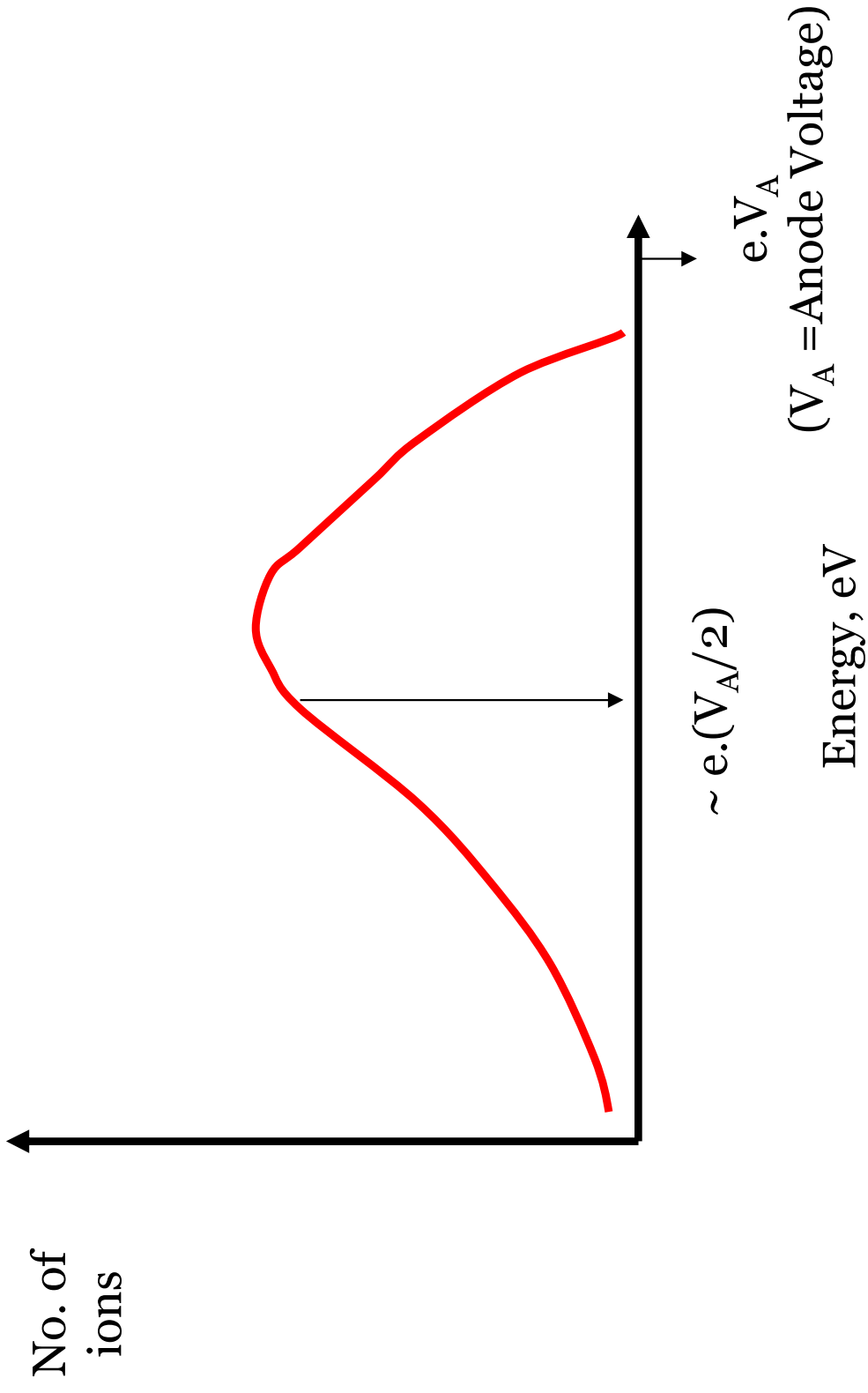
This area required high flow and secondary plasma made it unstable



IMC75 Characterization

Ion Energy Distribution for IMC75 Ion Source

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IMC75 Feedback Control

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Speedflo mini - up to 3 different gasses

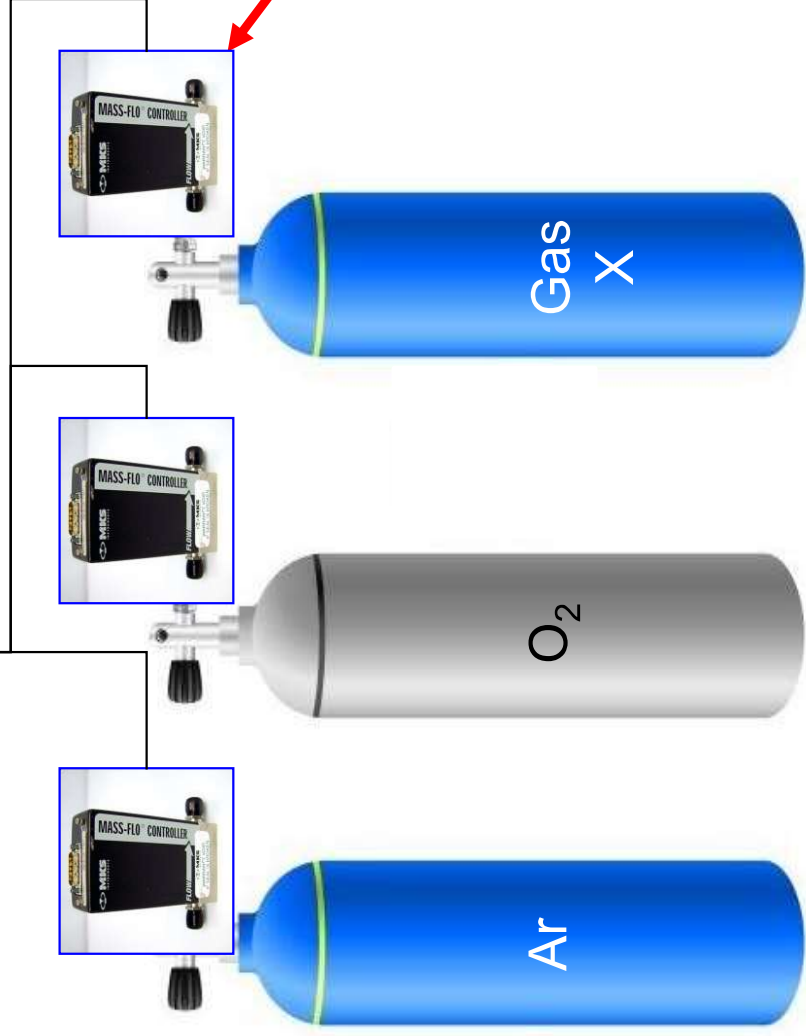


IMC75

V & I control
Beam energy control



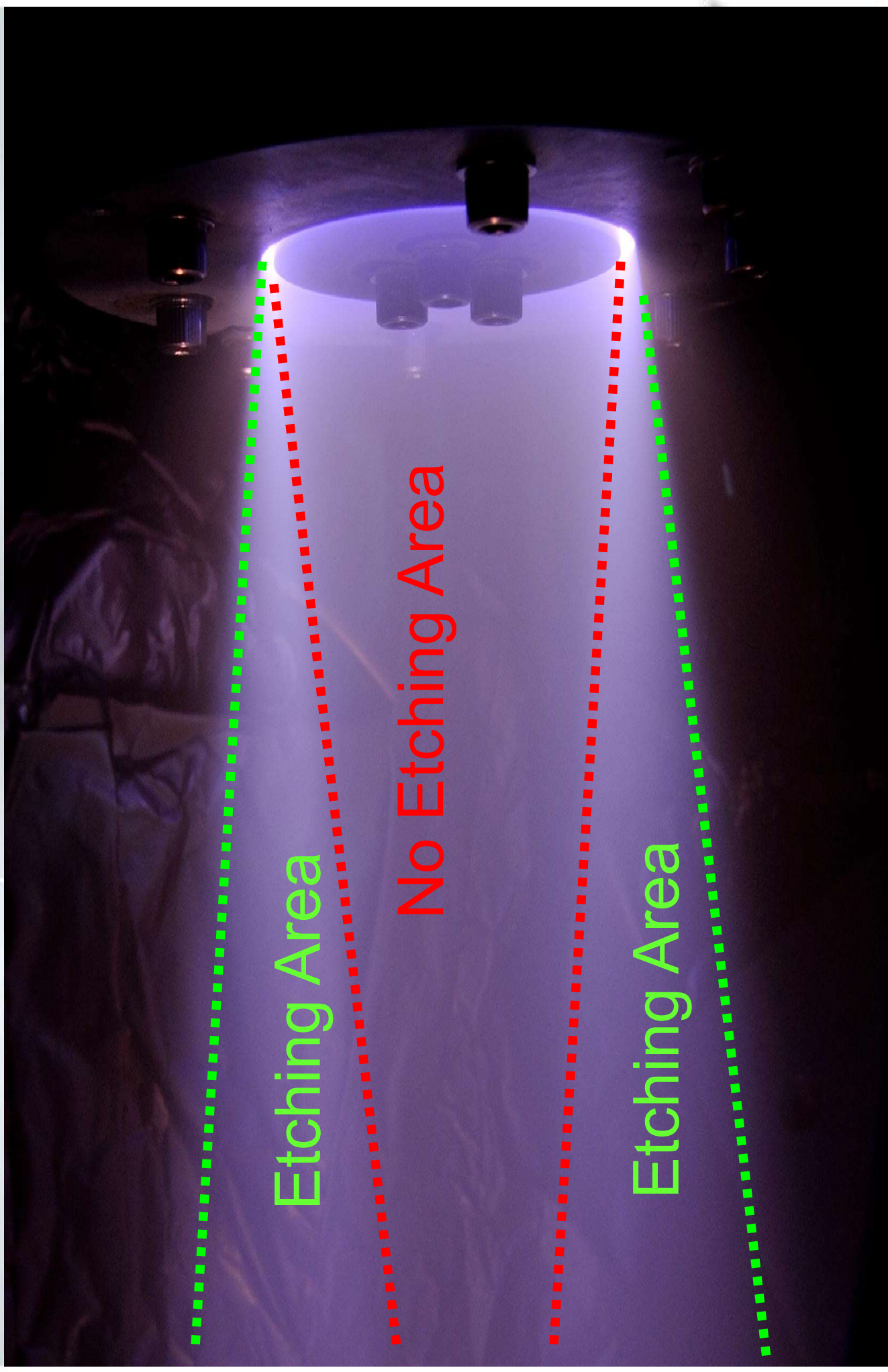
IMC75 PSU
1 gas control



Speedflo
Up to 3 gases
Speedflo Mini
Up to 8 gases



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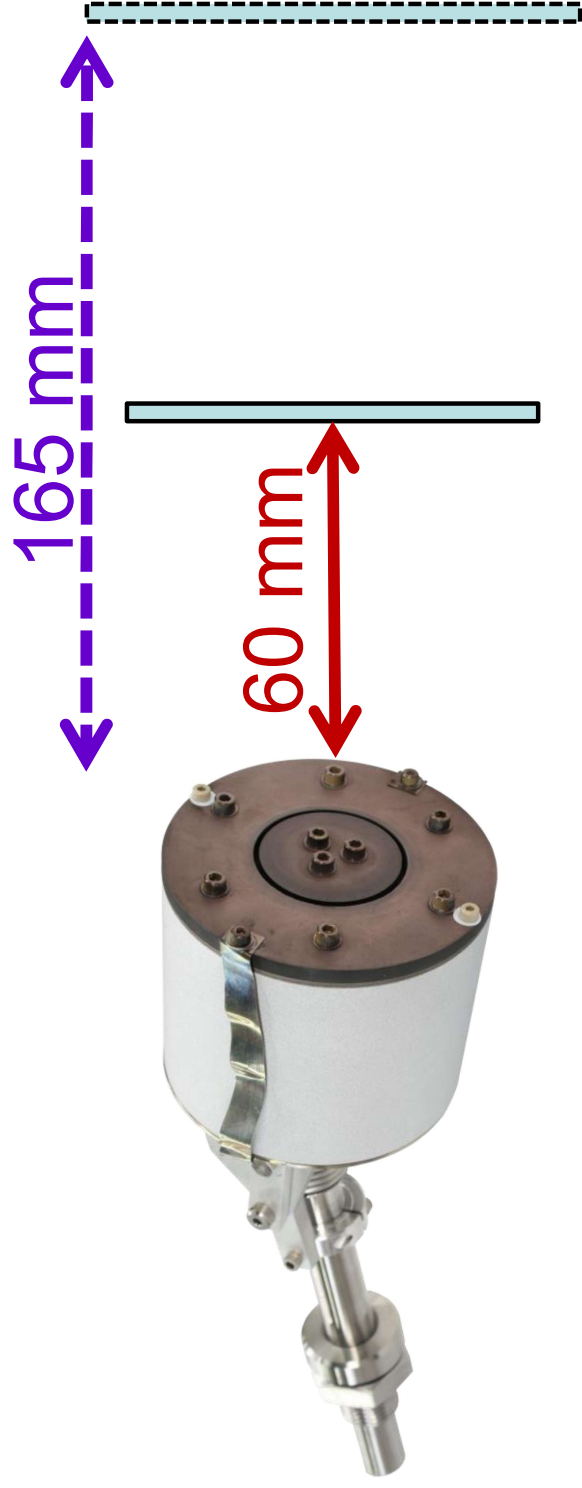


Etching Area

No Etching Area

Etching Area

Etching at different distances



Ion Source

Substrate



IMC75 Ion Etching

Etching Stainless Steel

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Copper on glass

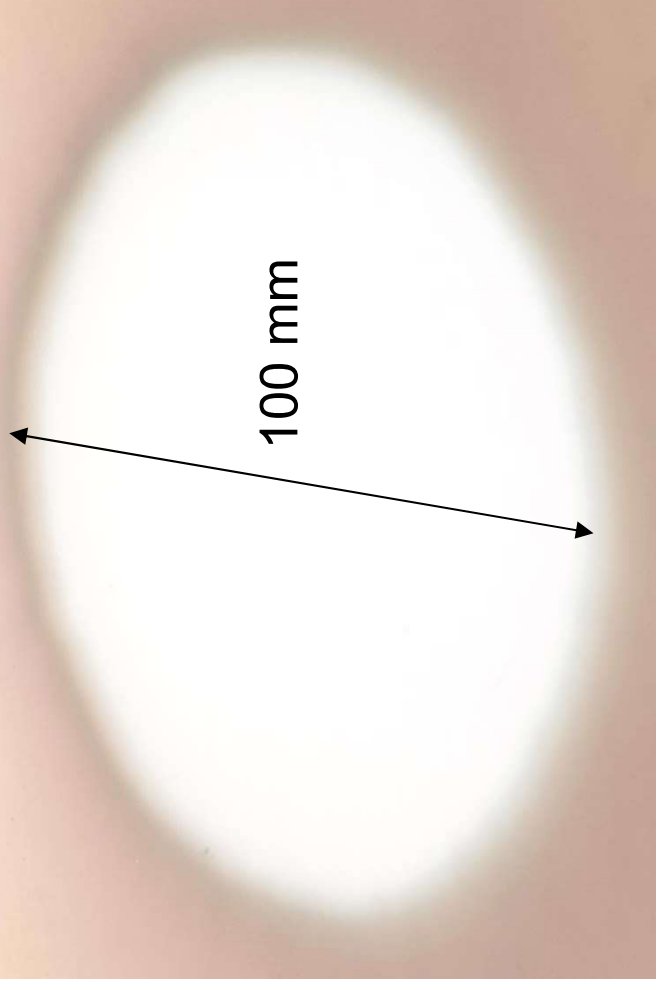
StSt on glass



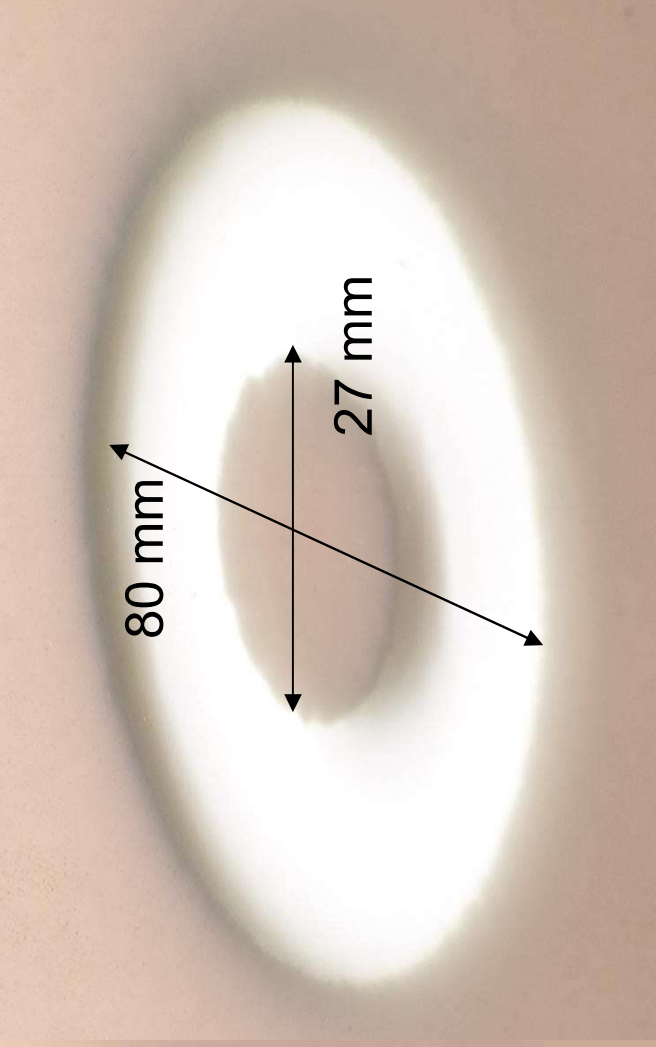
IMC75 Ion Etching

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Source to Substrate distance affects the area of etching. The integrated etching rate is practically constant over a very large distance range



165 mm



60 mm

IMC75 Ion Etching

Cu Etching Rate Measurements

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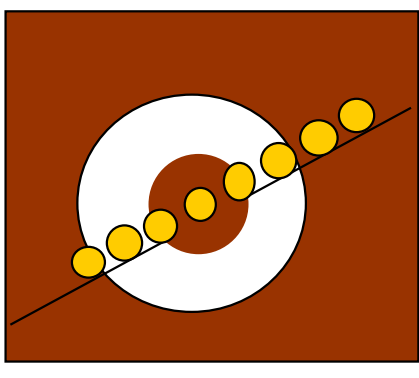
Crystal Sensors were coated with 1 μm Cu coating and arranged in a static array in front of the Ion Source. Etch rates were evaluated by the loss of Cu mass in different etching conditions



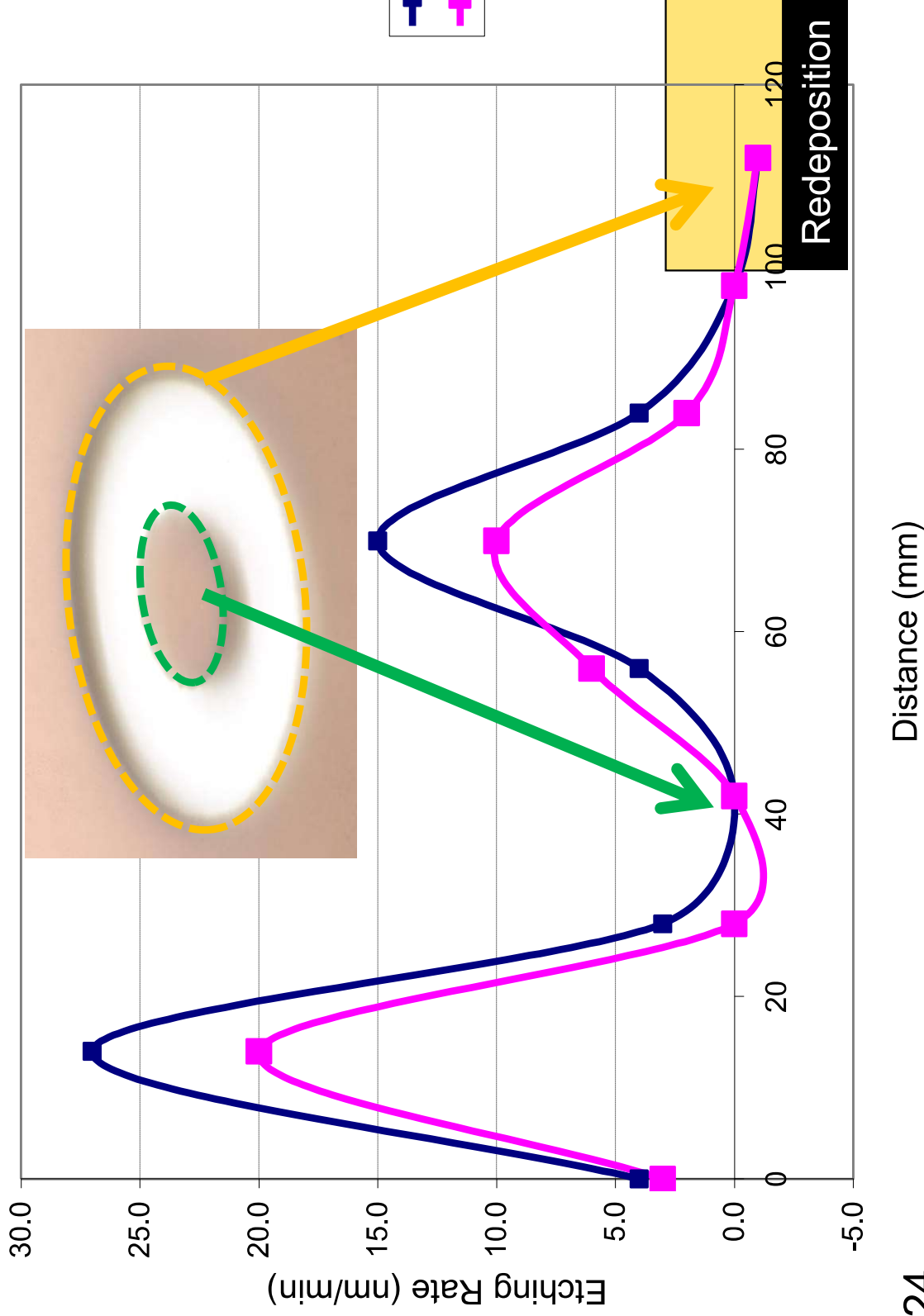
IM75 Ion Etching

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Etching at 60 mm



60 mm - Argon



- Cu etching rate at 2kV
- Cu etching rate at 1.5kV

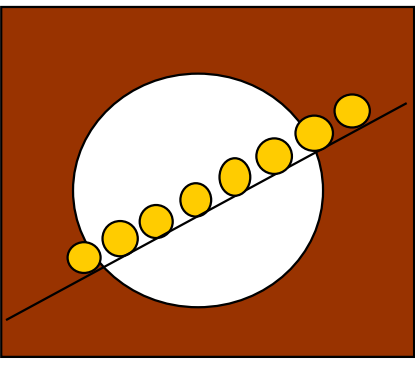
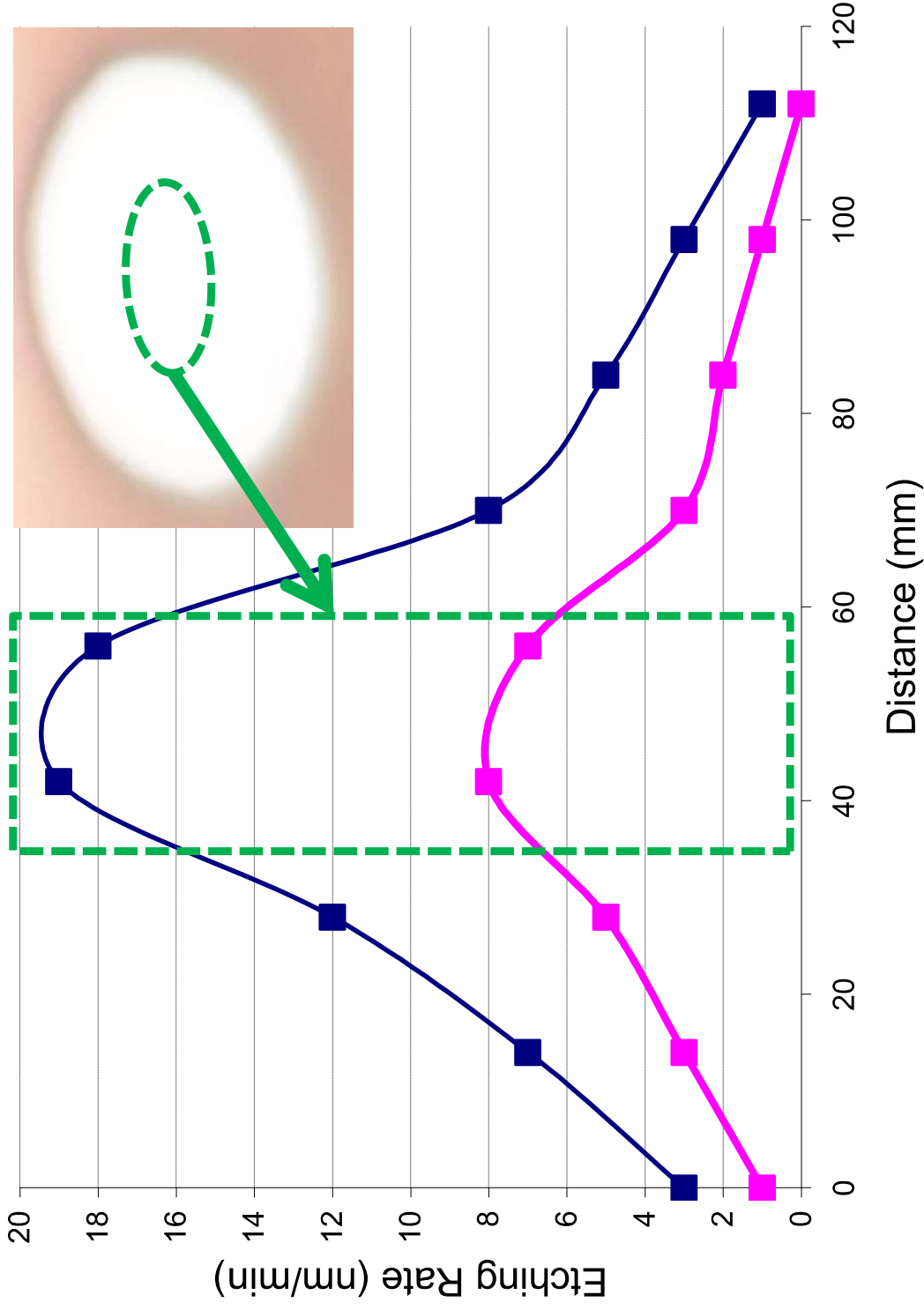


IM75 Ion Etching

Etching at 165 mm

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165 mm - Argon



- Cu etching rate at 2kV
- Cu etching rate at 1kV



IMC75 Ion Etching

Etching Stainless Steel

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165 mm



60 mm

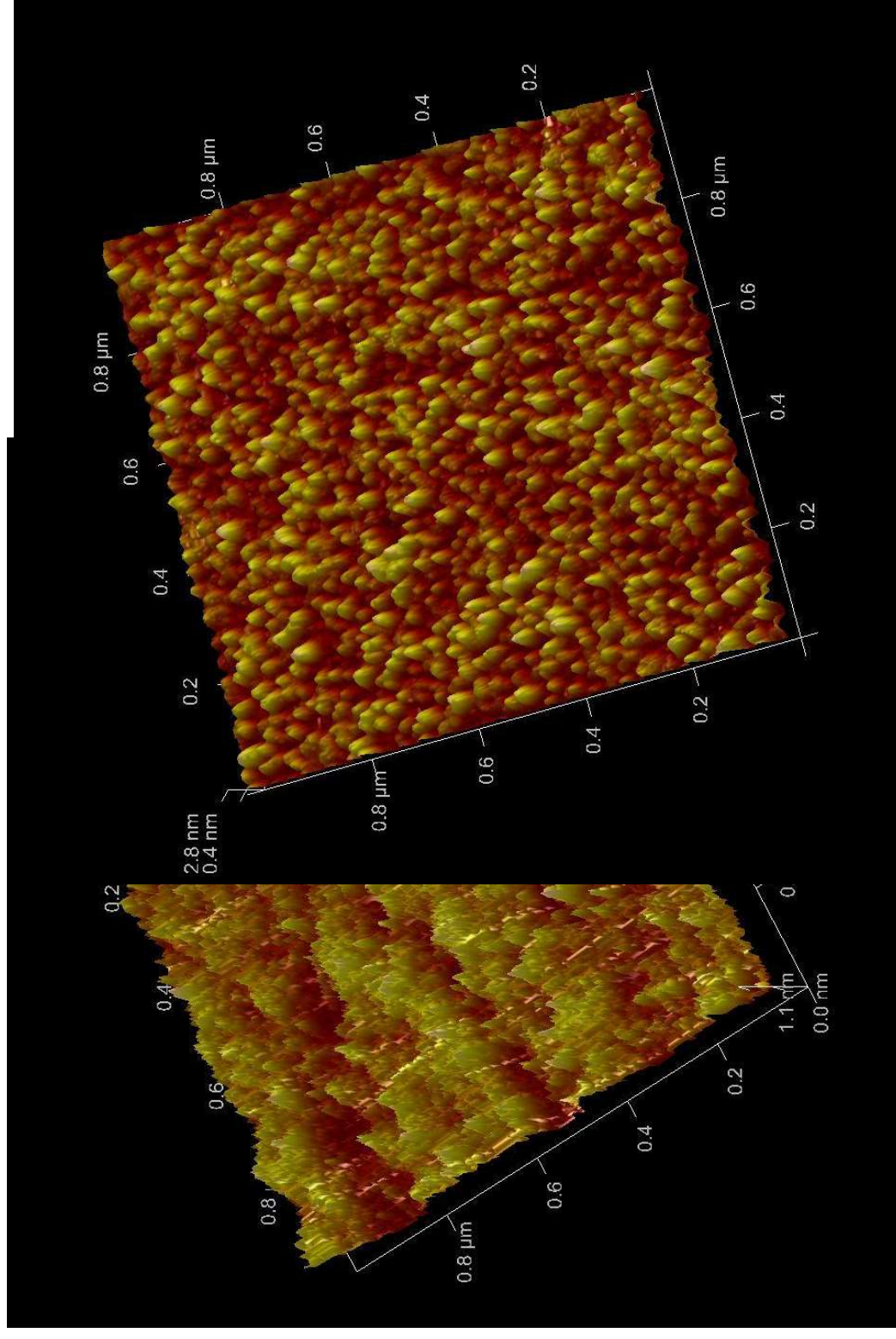


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Untreated Zerodur

AFM was proven to be the best tool to visualize the effect of the ion treatment.

The sample here is as received with no treatment



Diamond-Like Deposition

Ethylene DLC

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Genco provide a unique customer built power supply that automatically regulates

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two gas flow for ease of operation

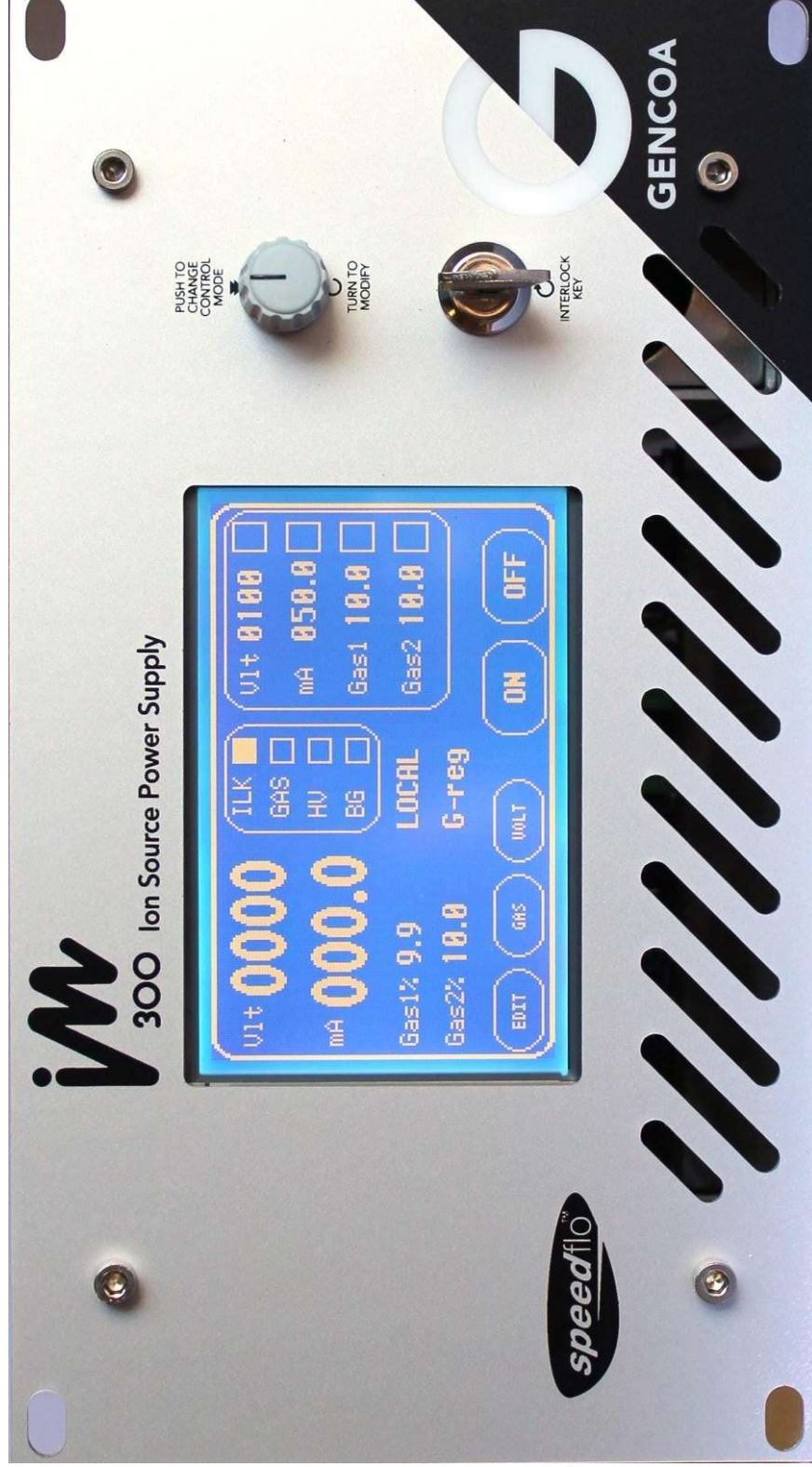
Output voltage
Output current
Output Power
Output polarity
Regulation Mode
Output connector

Weight
Cooling
Working temperature

Up to 2500V (3000V ignition voltage)
550 mA
1750W @ 2500V
Positive
Current 0-0.7A
Fischer, type 105, 10kV rating for
RG213 coax cable
3kg
Forced air cooling
15-35° C

Active Front Panel - Touch screen display ,240x 128 pixel
Automatic voltage tracking by dynamic flow adjustment
for constant voltage (requires MKS 1179A MFC) (VT) - 2
channels, analog 0 to 5V , supply +-15V ,max supply
power 10 Watts.

Input 240 AC or 115 ac switch selector inside max 500va
Size 3UI rack mount L=480mm H=178mm D=300mm
CE Mark



Schematic of the ion source with power supply and automatic gas regulation

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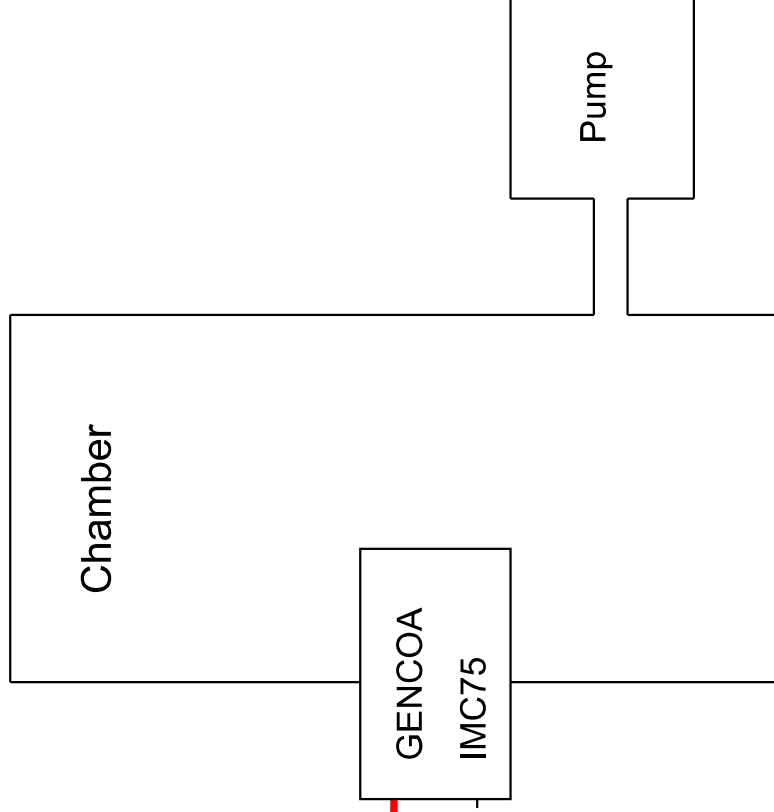
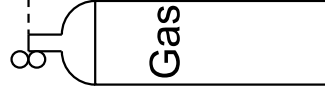
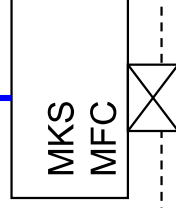
Removes beam variation – I & V regulated



**IM300
Power
Supply**

Power Cable

MFC cable (for
MKS's MFC), D9-
D15 Shielded



MFC Spec:
MKS 1179A
Db15
 $\pm 15V$



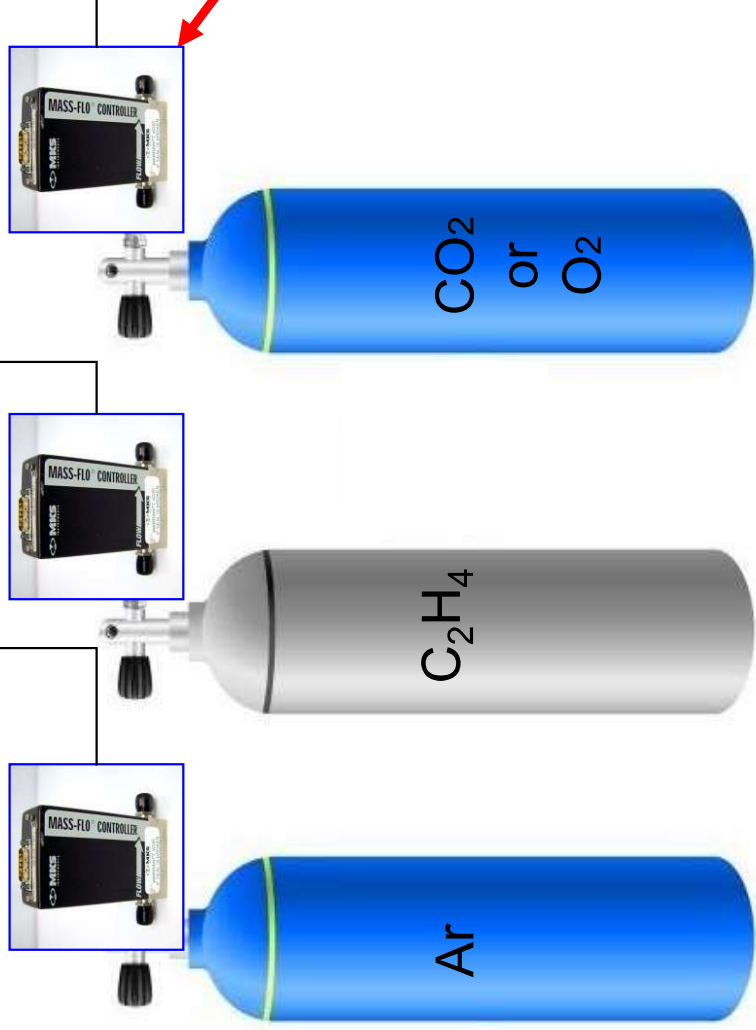
IM75 Feedback Control for 3 or more gases

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Ethylene DLC



RG142 cable
(power)



DB25 to BNC cable
(V feedback)



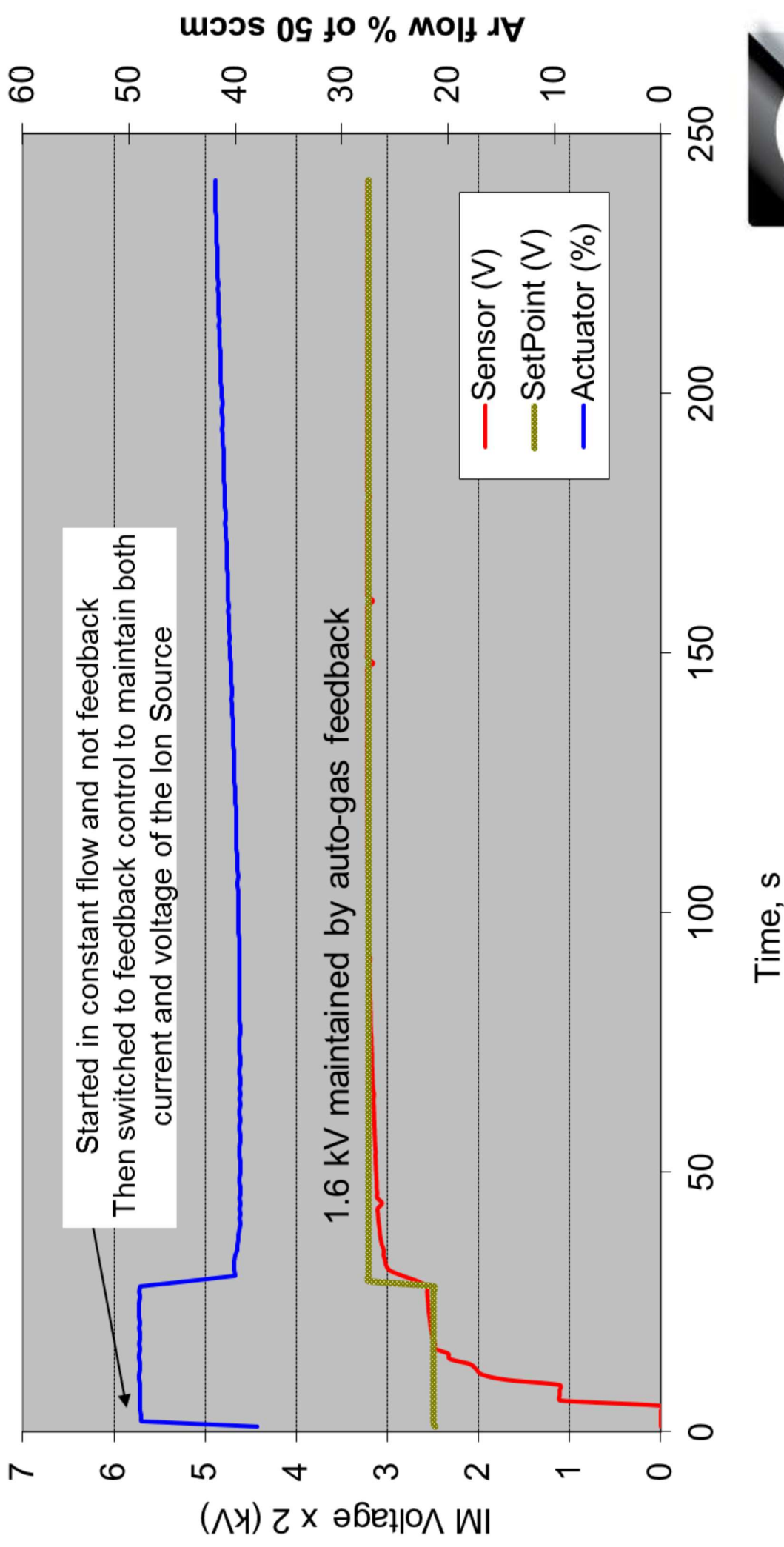
Oxygen could also be added to the process in order to harden the DLC in a more sp^3 structure



IM600 at 300mA - gas Ar - Example of voltage tracking

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feature via auto control of gas

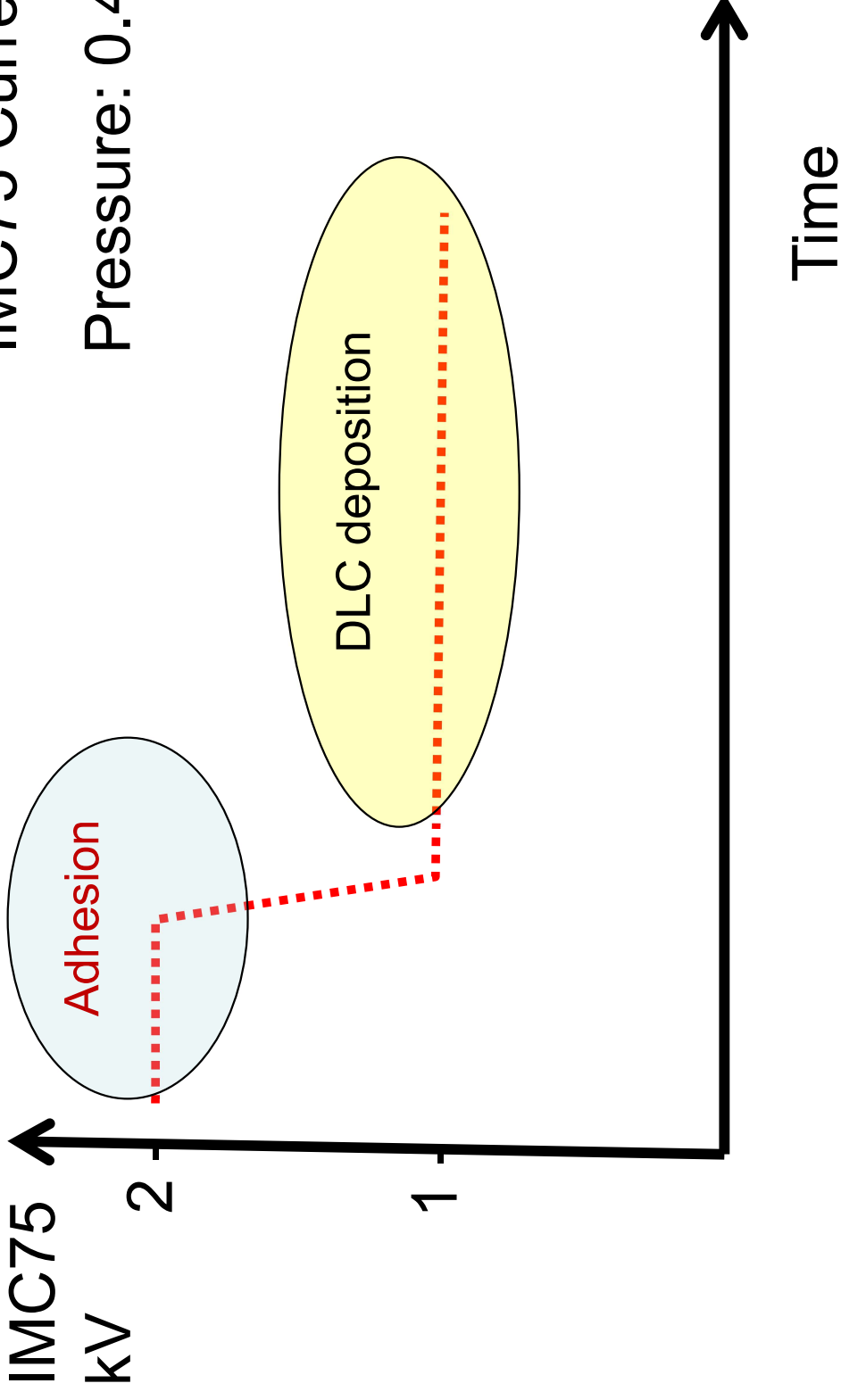


Diamond-Like Deposition

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DLC process

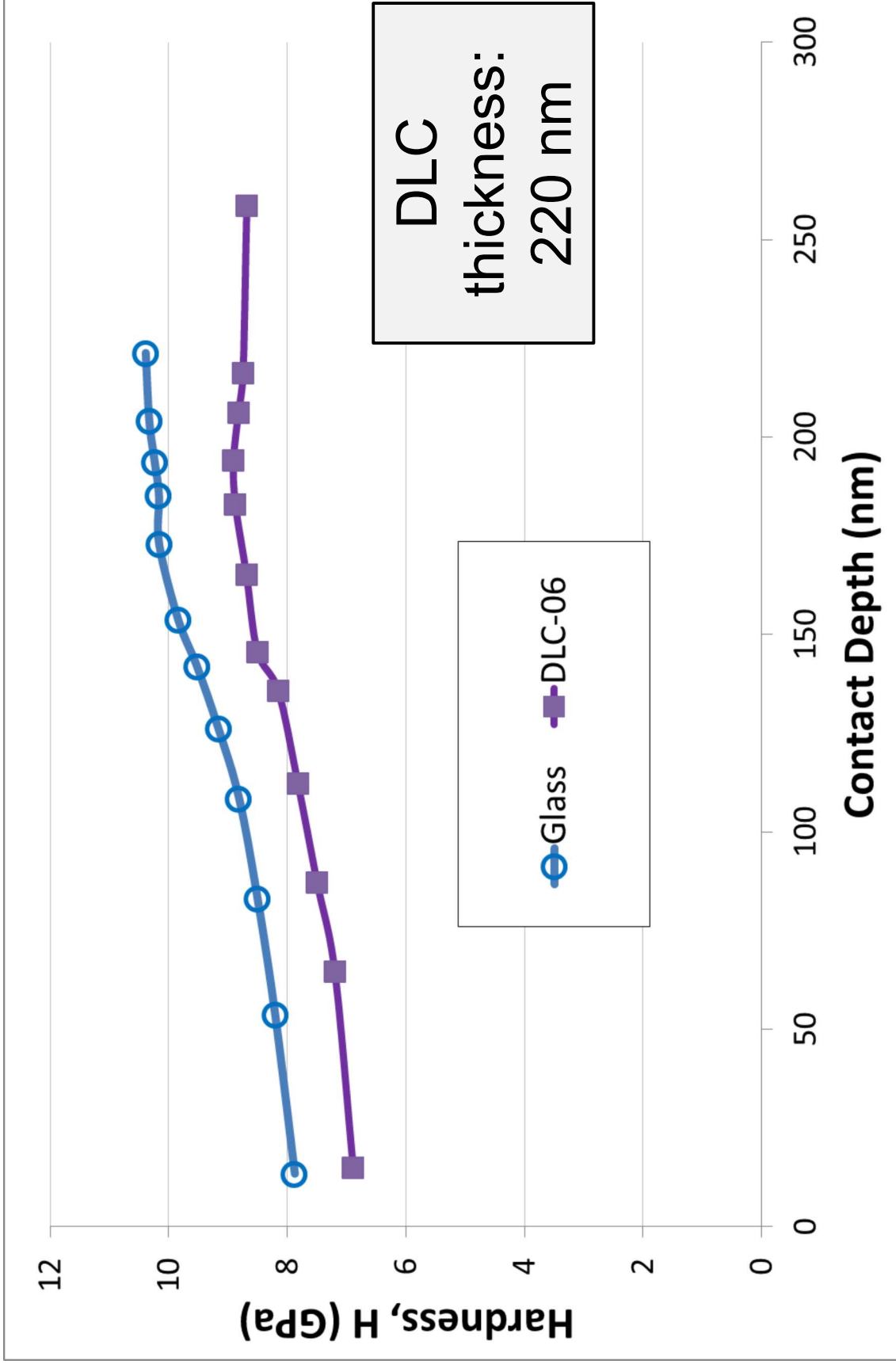
IMC75 Current: 45 mA
Pressure: 0.4 – 3 mTorr



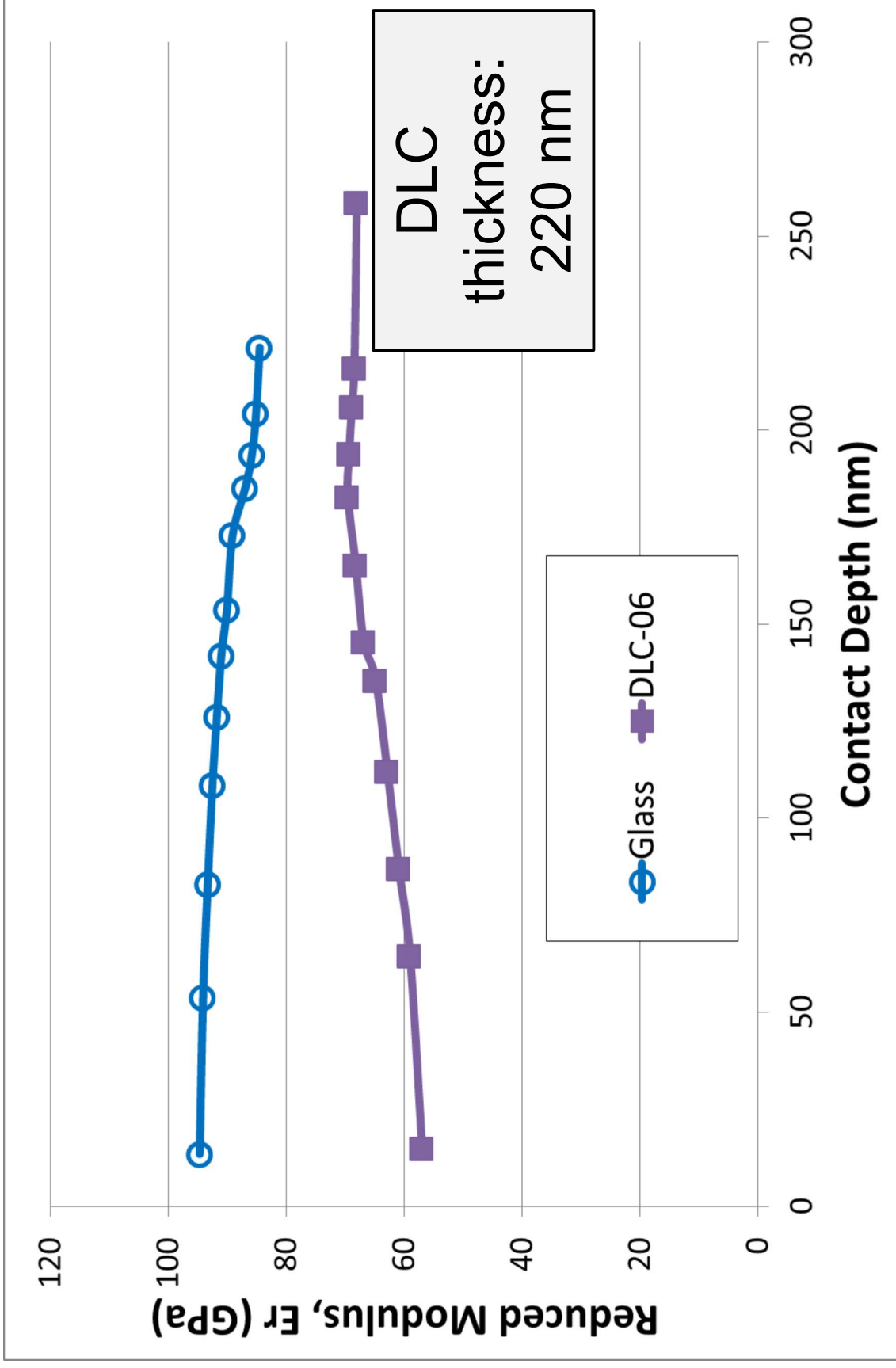
Process Control : feedback mode



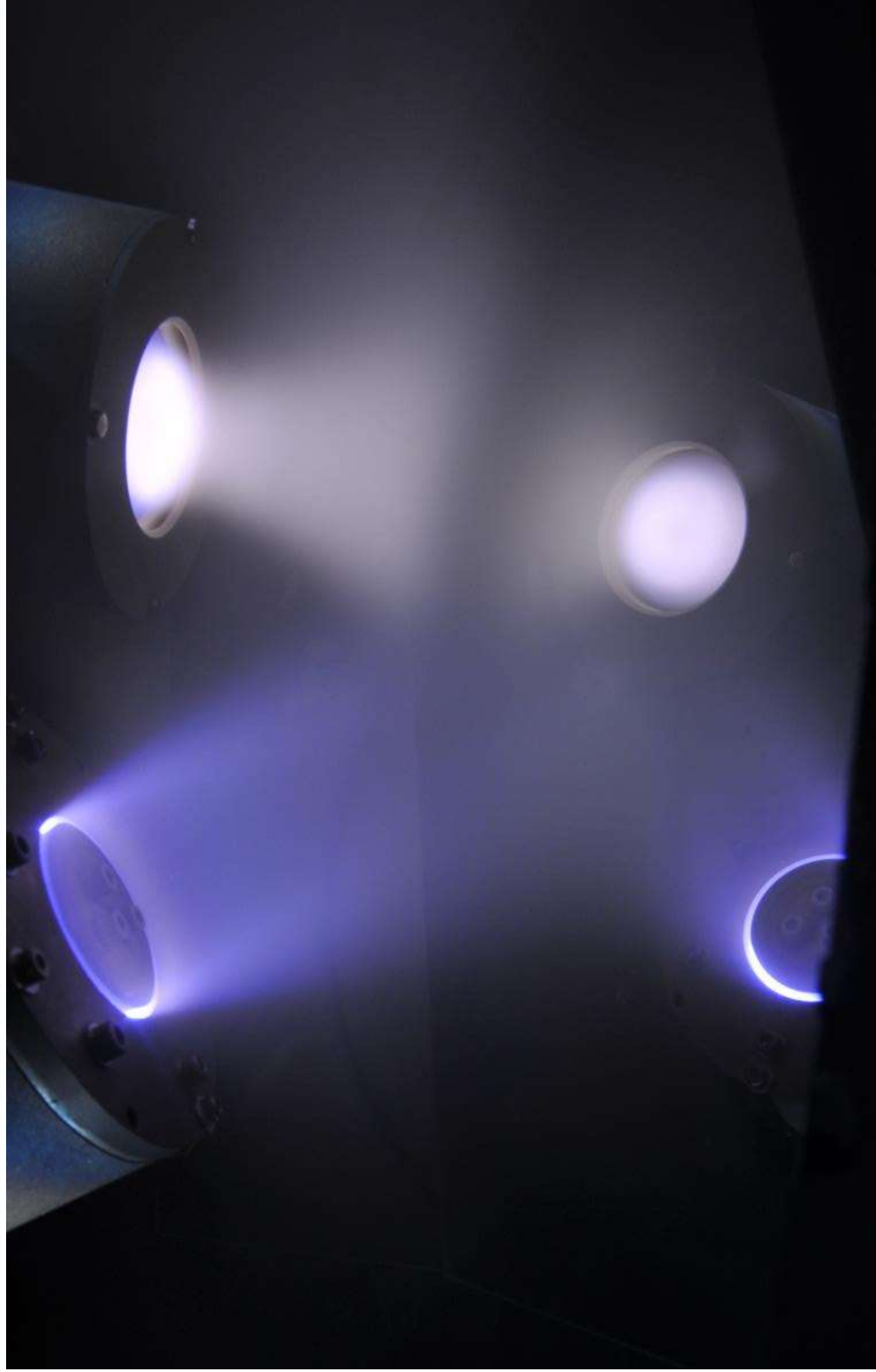
Loads from 100 μN to 10000 μN



Loads from 100 μN to 10000 μN



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IMC75 Characterization

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Operation Range for IMC75 Ion Source

- Inverted Magnetron Ion Beam
- Grid/Filament-less ion source – Long maintenance & no contamination.
- Self-neutralised ion beam
- Operating pressure in large pressure range (E-4 to E-3 mbar)
- Tilting head – ion angle control.
- Stable ion beam current and ion energy distribution due to integrated closed loop feedback control
- Variety of gas feeds possible
- Suitable for pre-treatment of both metals, polymers and ceramics
- Scalable to linear ion sources for large scale production equipment due to similar operating characteristics



Thanks & Open for Questions

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THANK YOU
FOR YOUR ATTENTION

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