BURLE ELECTRO-OPTICS

The Development of A Novel, Cold Electron Source Paper 328

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Objective

The Objective of this development project was to determine if the microchannels within a microchannel plate could be modified to function as spontaneous electron emitters.

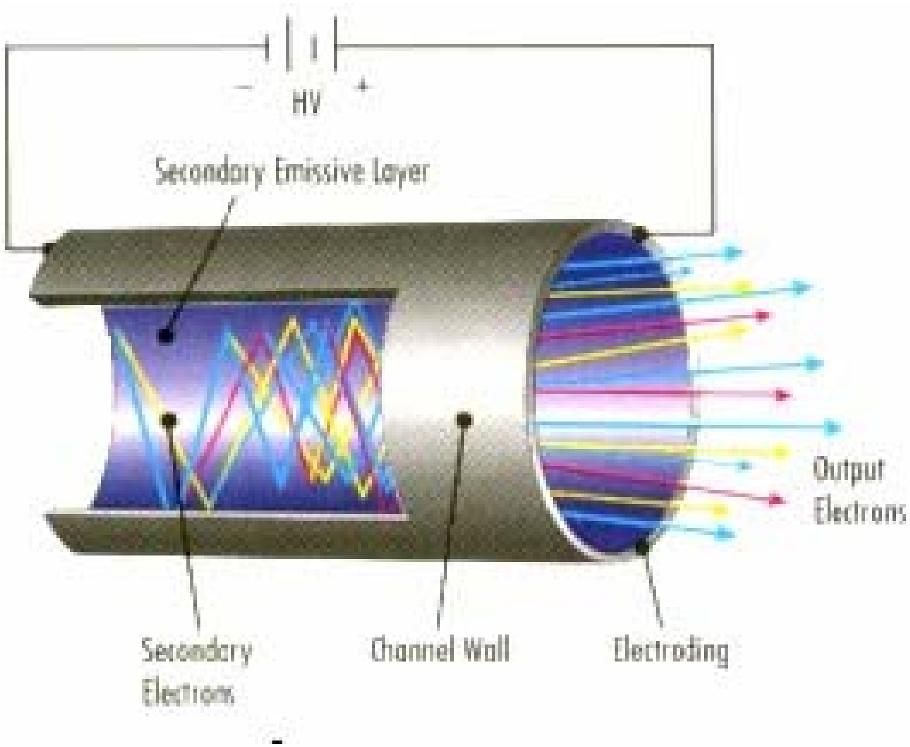
Microchannel Plates (MCPs) are arrays of millions of single channel electron multipliers. These devices are routinely used in mass spectrometers to detect and amplify weak ion signals. MCPs are manufactured in sizes ranging from 2 – 150 mm in diameter.

Experimental Method

Microchannel Plates operate on the principle of secondary electron emission. When a charged particle impinges on the input side of the channel with sufficient energy, a few secondary electrons are produced. The resultant electrons continue to cascade down the channel until a charge cloud exits the channel.

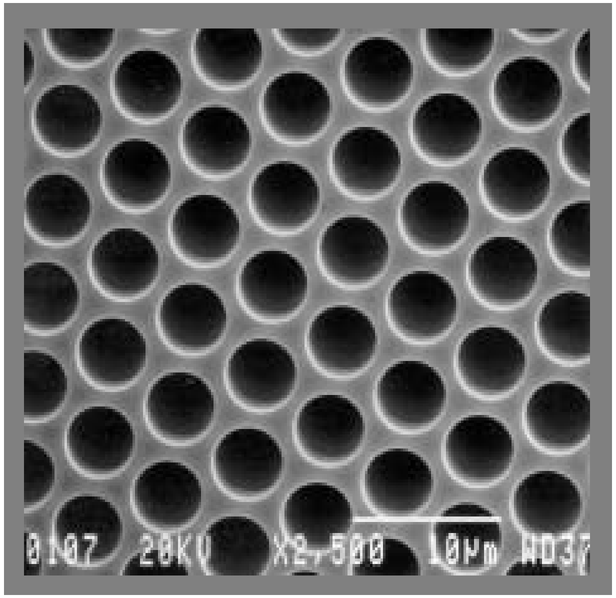
It was believed that by altering the microstructure within the channel, spontaneously emitted electrons could be produced, which would initiate the cascading of secondary electrons. By controlling the rate of spontaneous emission and the gain of the device, the emission current could be varied over a broad range.

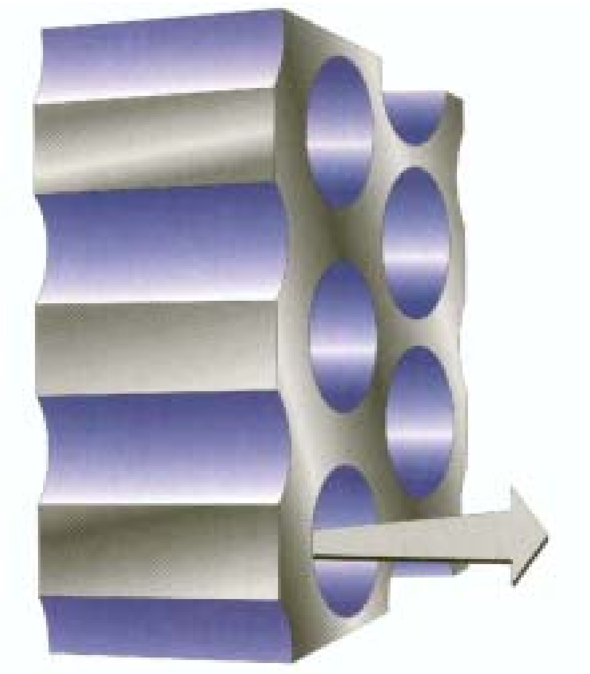
Theory of Operation



Electrons are spontaneously generated and amplified inside the channel when voltage is applied.

Theory of Operation





Millions of channels are fused into virtually any shape and size to provide a uniform electron flux.

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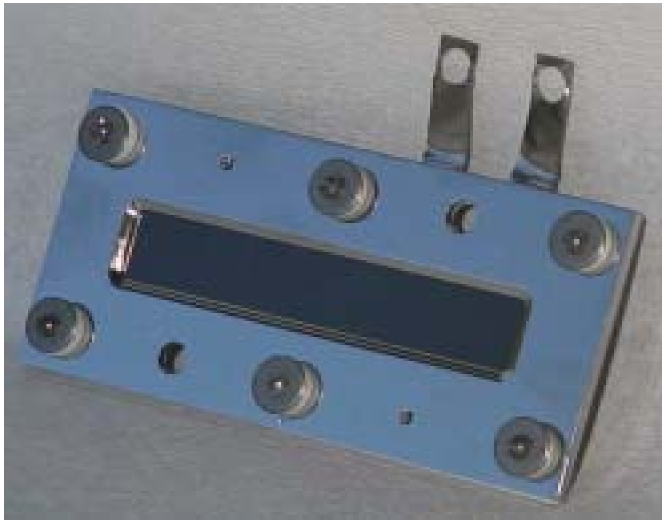
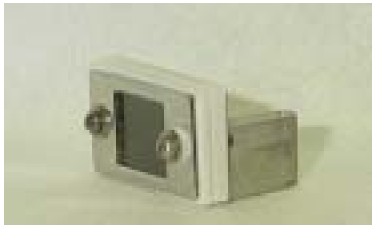
Various Format Electron Generator Arrays



50 x 8 mm

40 mm

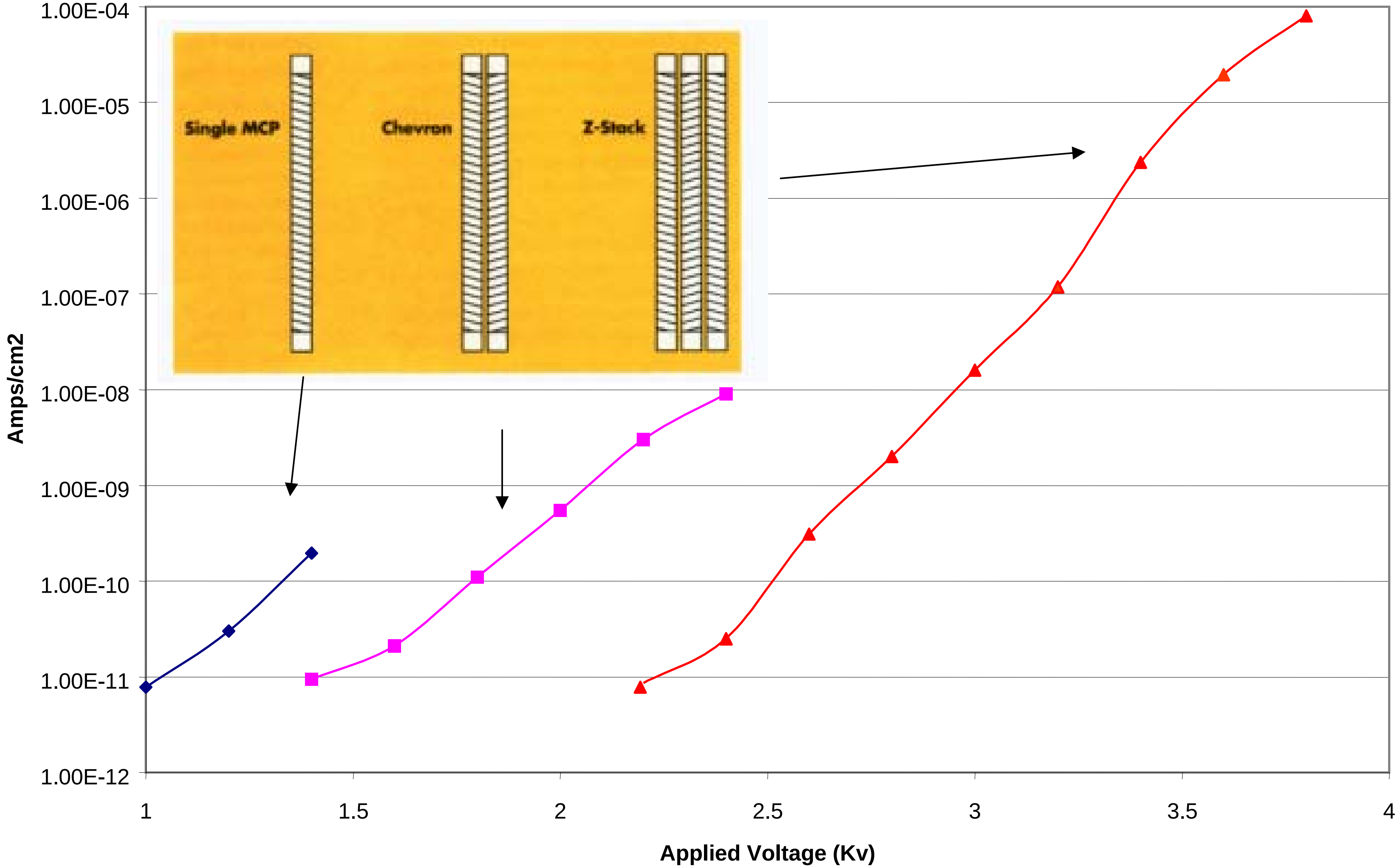


11 x 12 mm

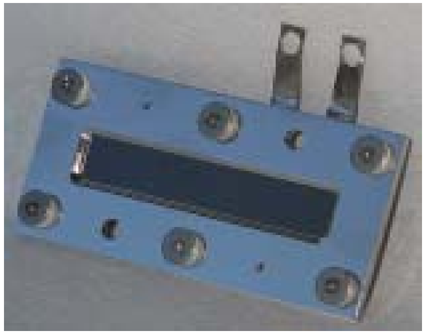
18 mm

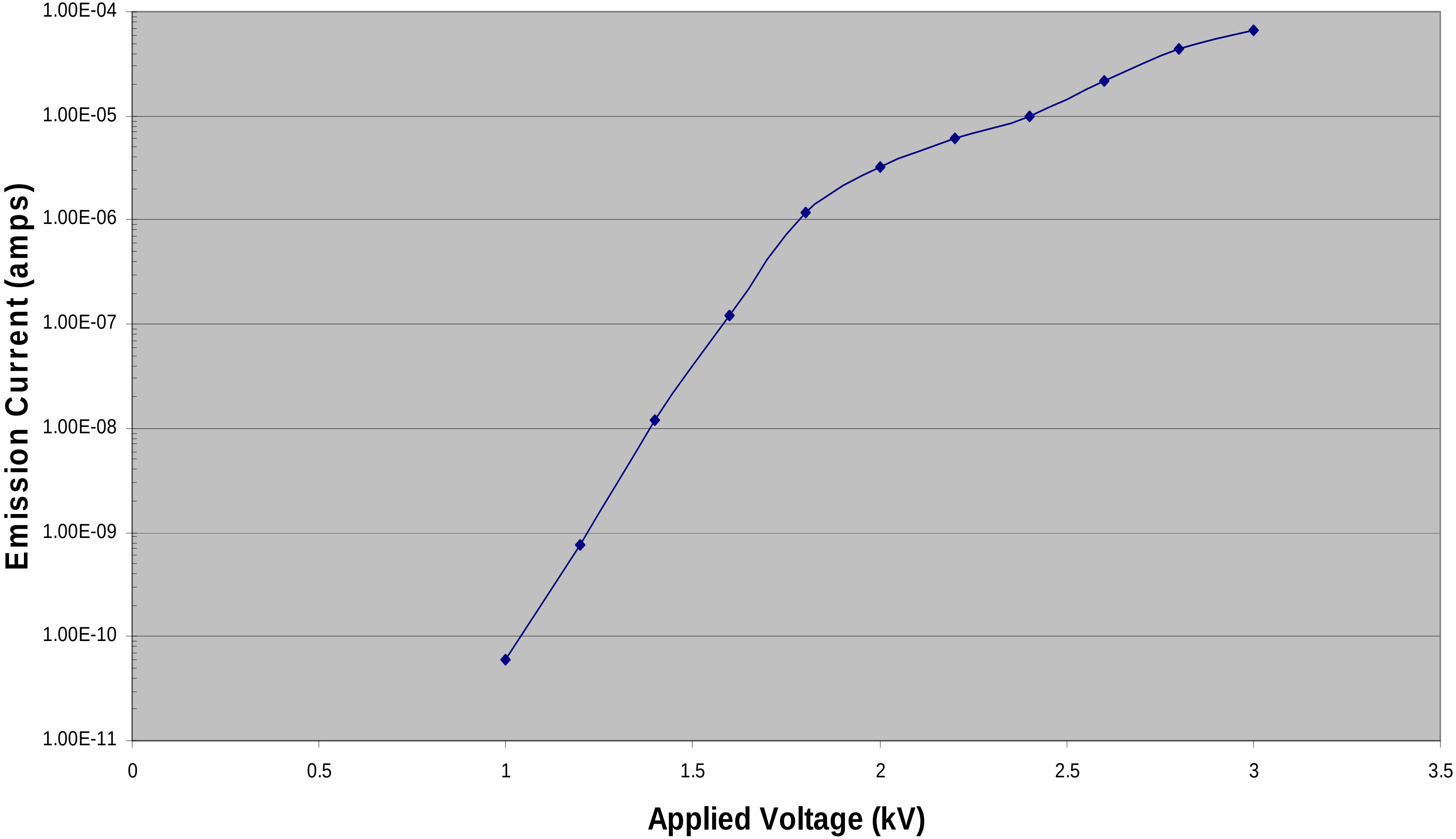
8 mm

Emission Current 18 mm Format

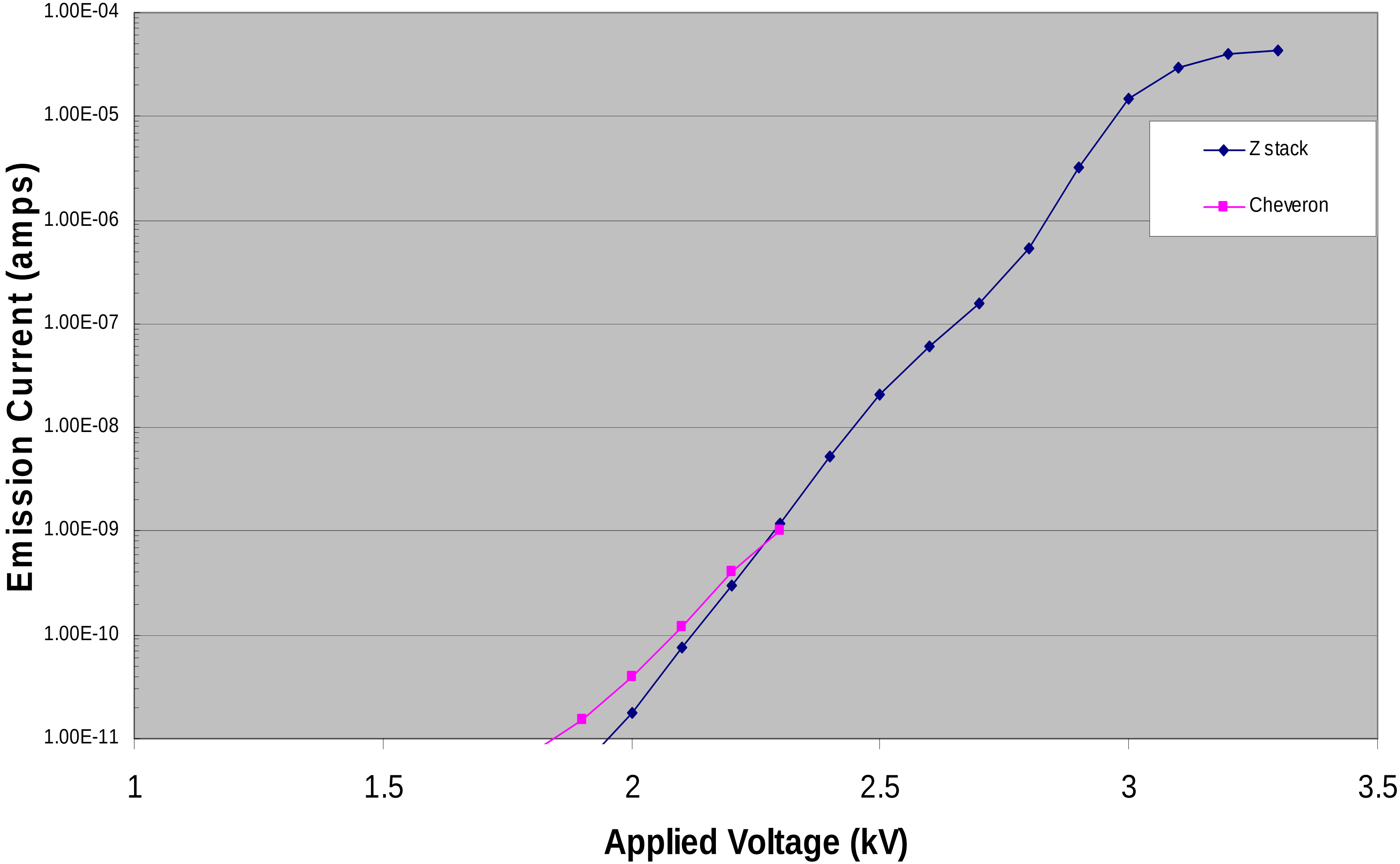


50 x 8 mm Emission Current





10 x 12 mm Emission Current



8 mm Microtron™ EGA

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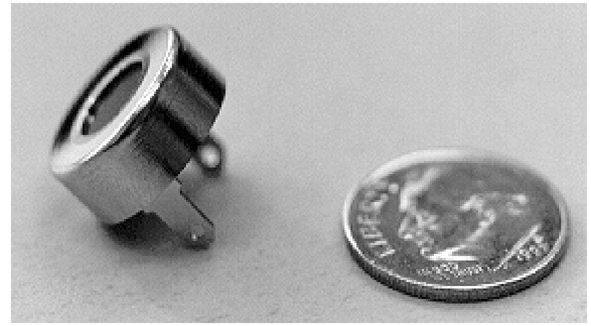
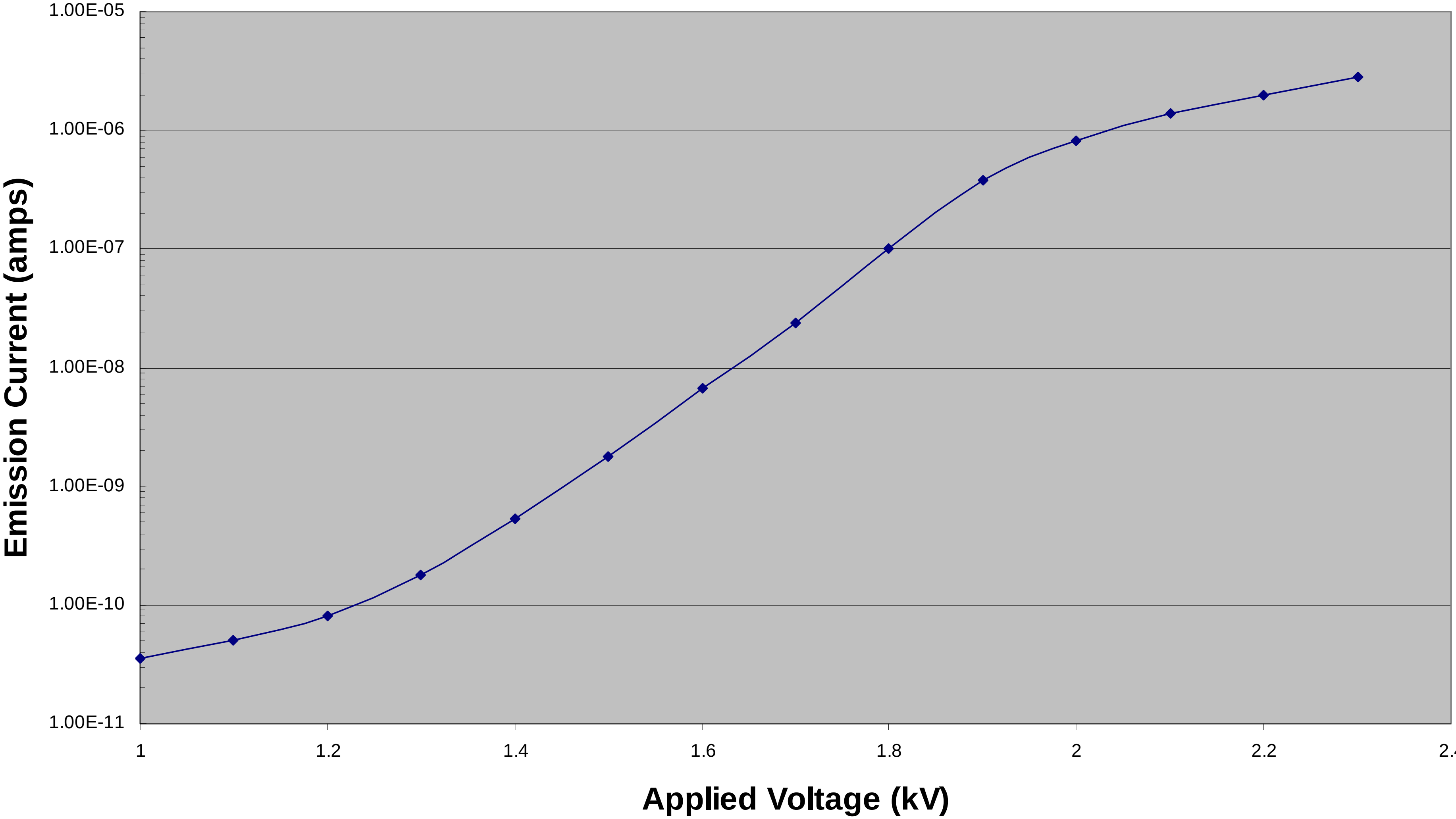
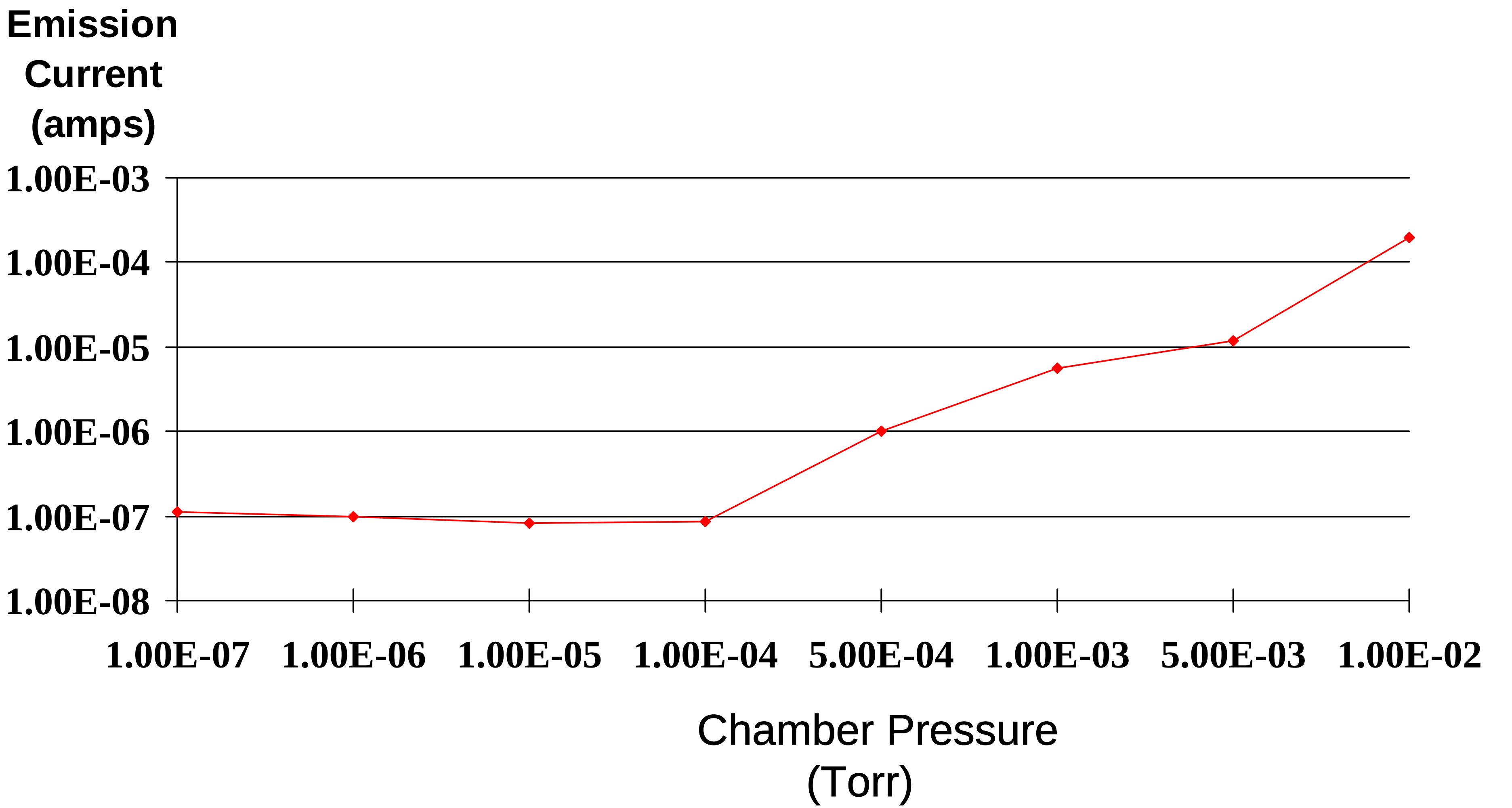
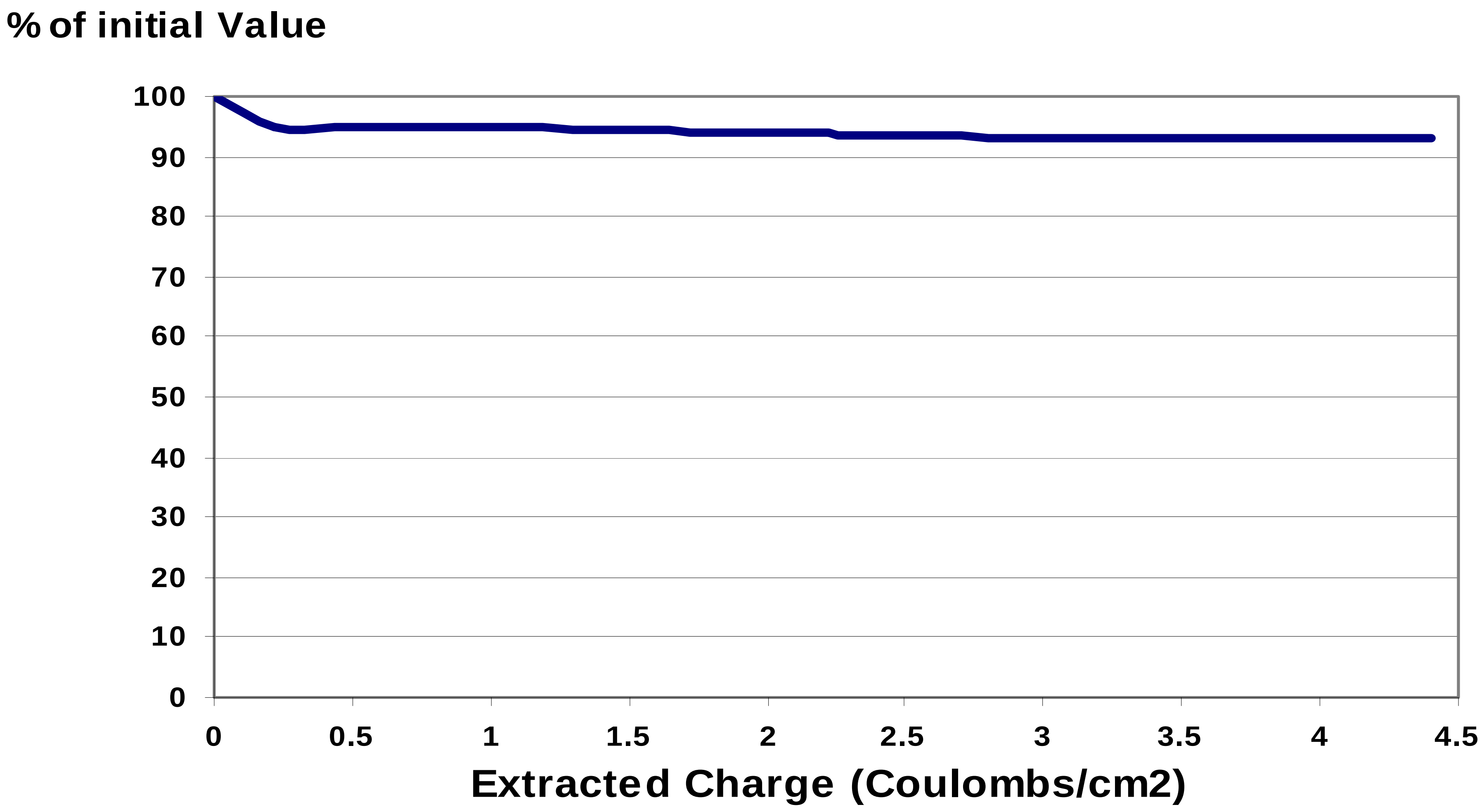




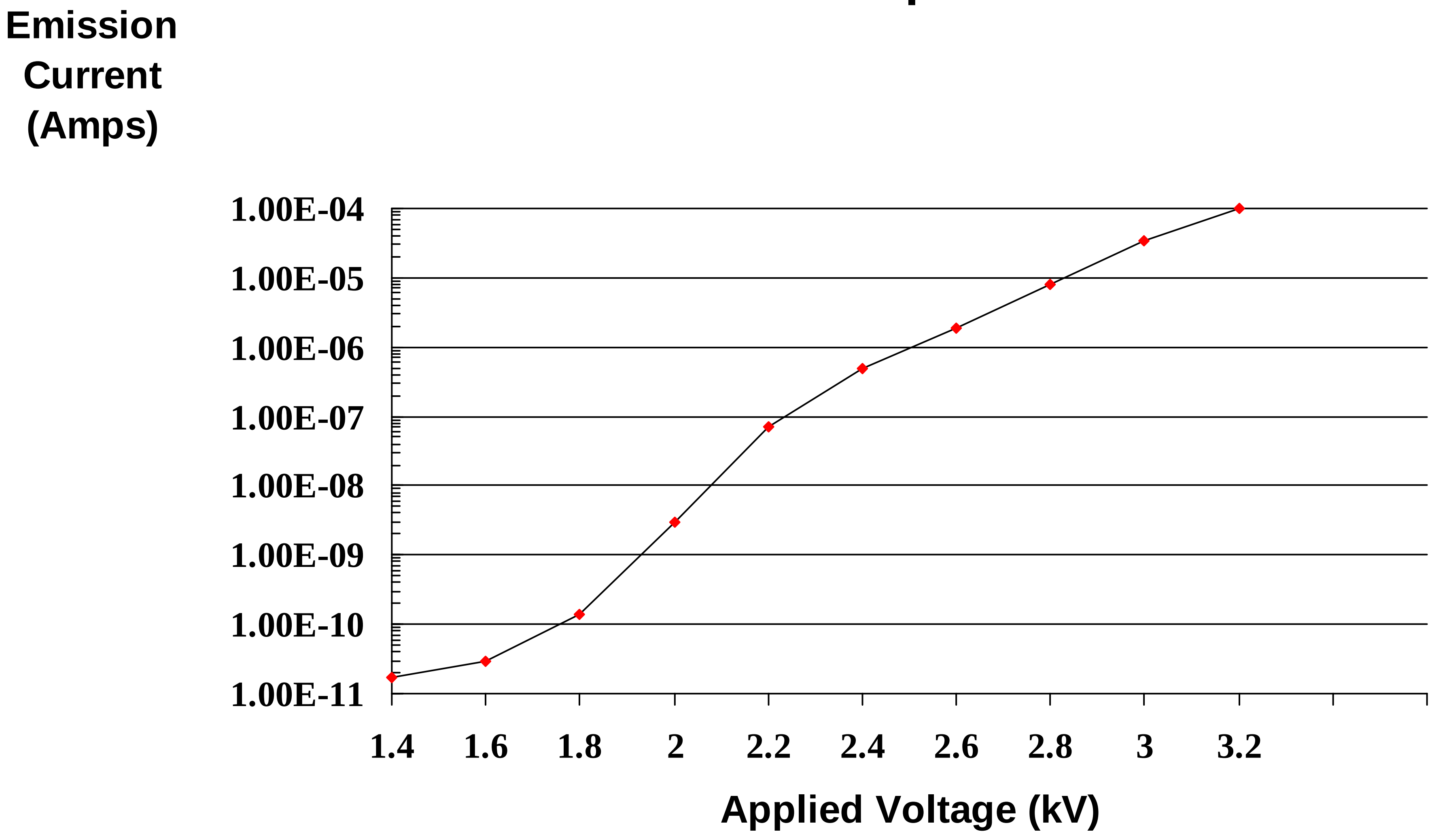
EGA Electron Source Emission Current vs. Chamber Pressure, Backfill Argon



ELECTROGEN™ Stability



Z-Stack 5 um pore, after 144 hours of operation



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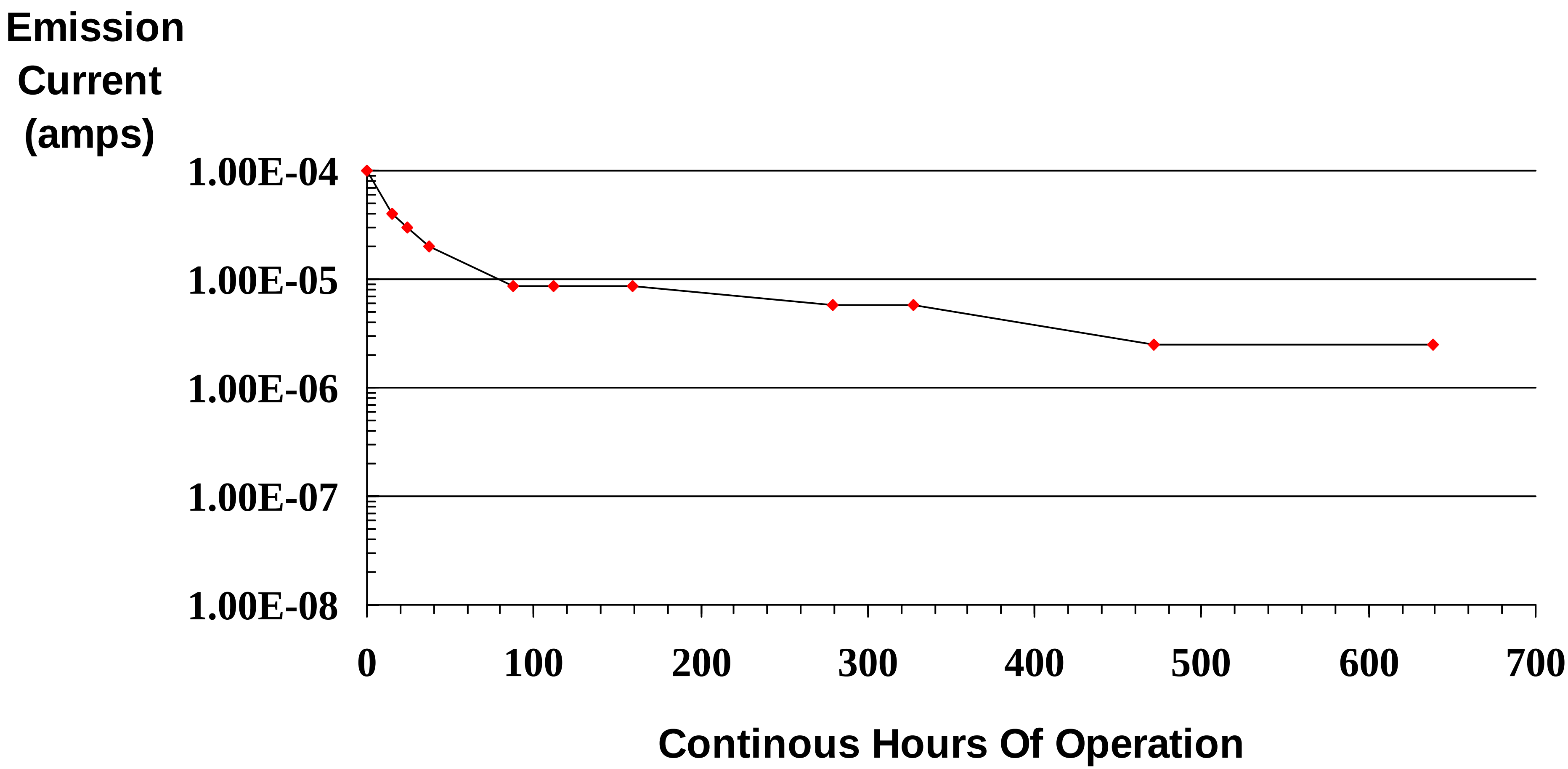
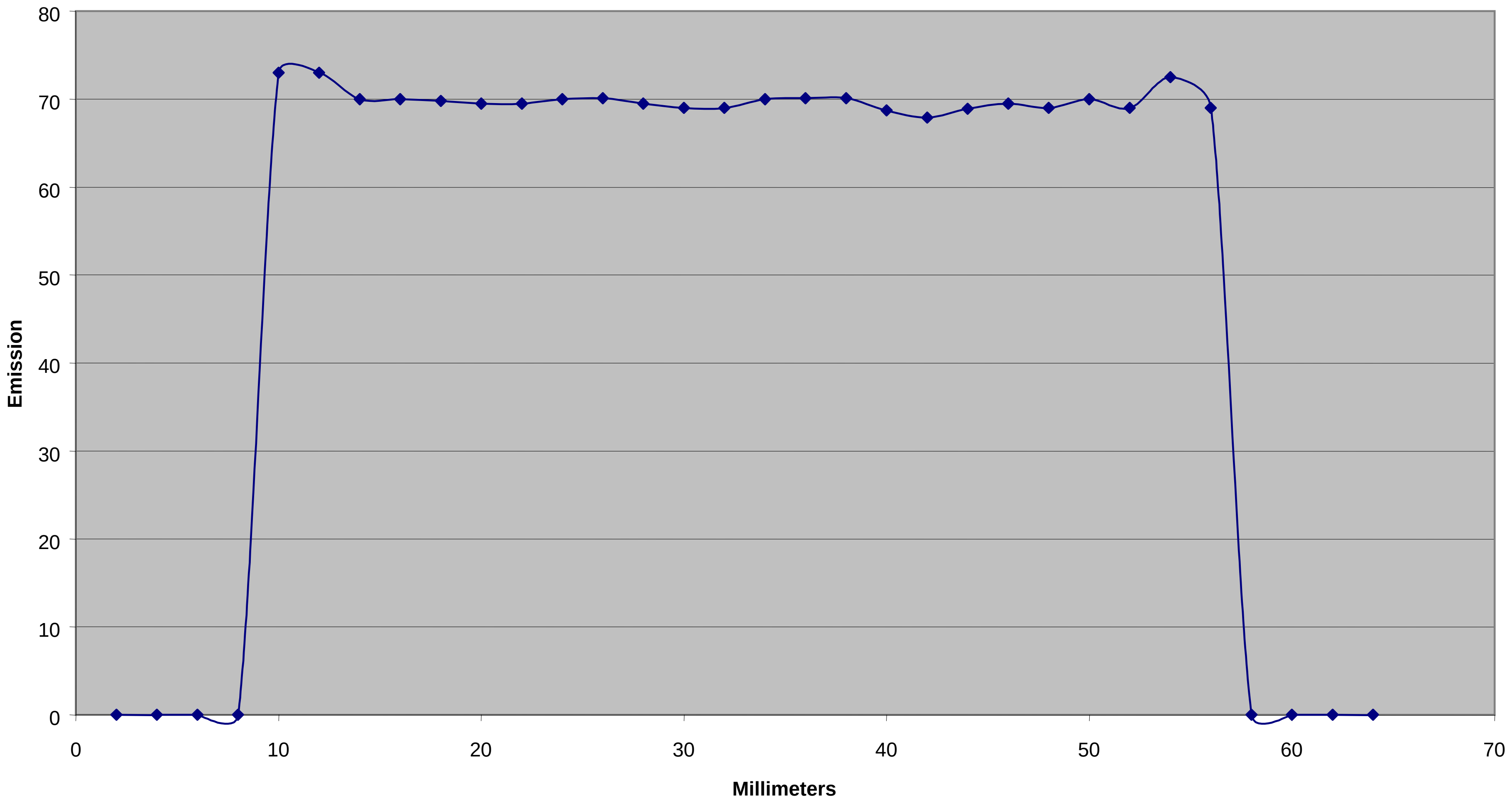
Operational Life Time In PFTBA at 4 x 10^{-4} torr



Emission Uniformity and Beam Definition
50 x 8 mm Array, Z-Stack Configuration



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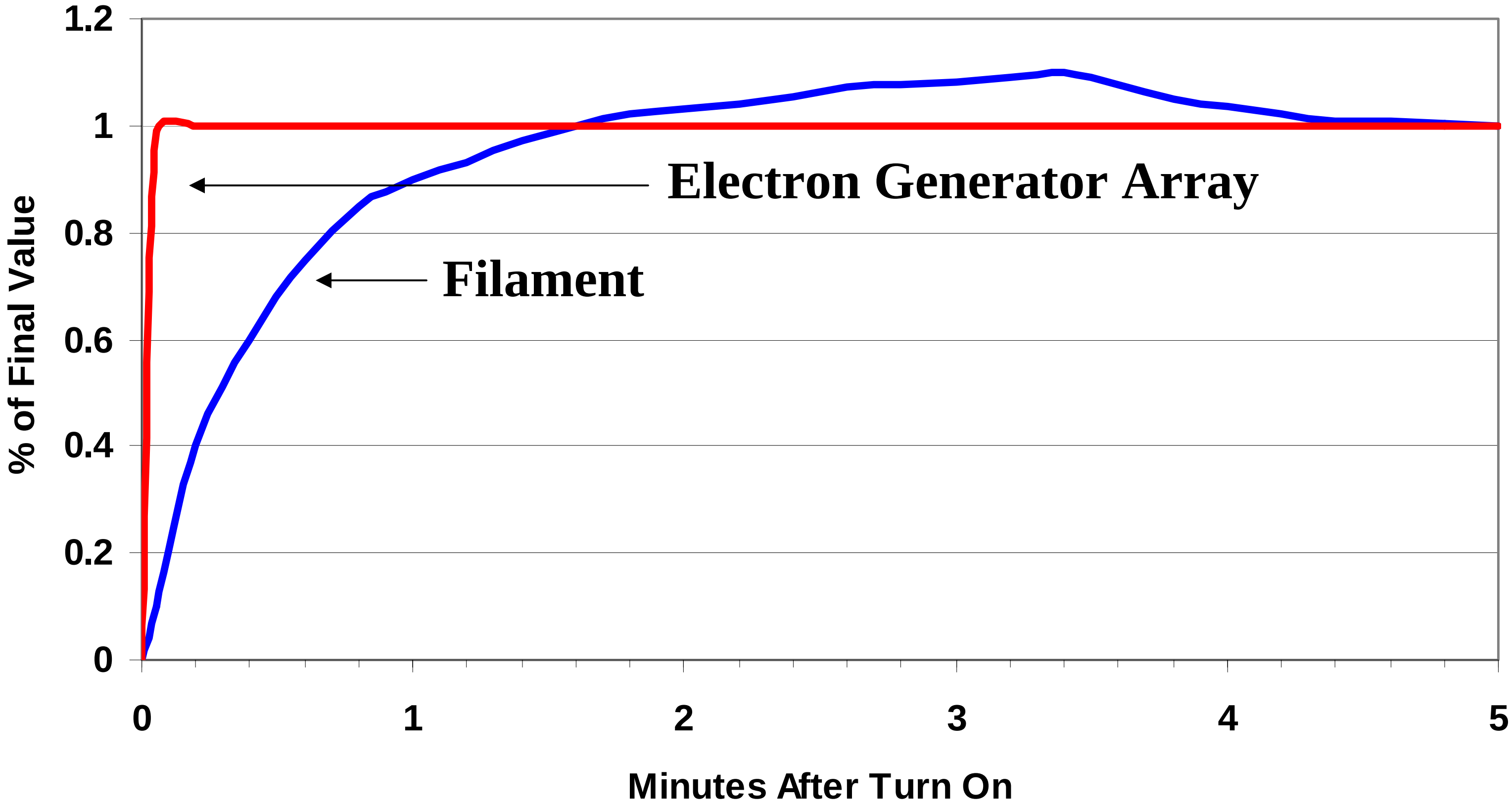
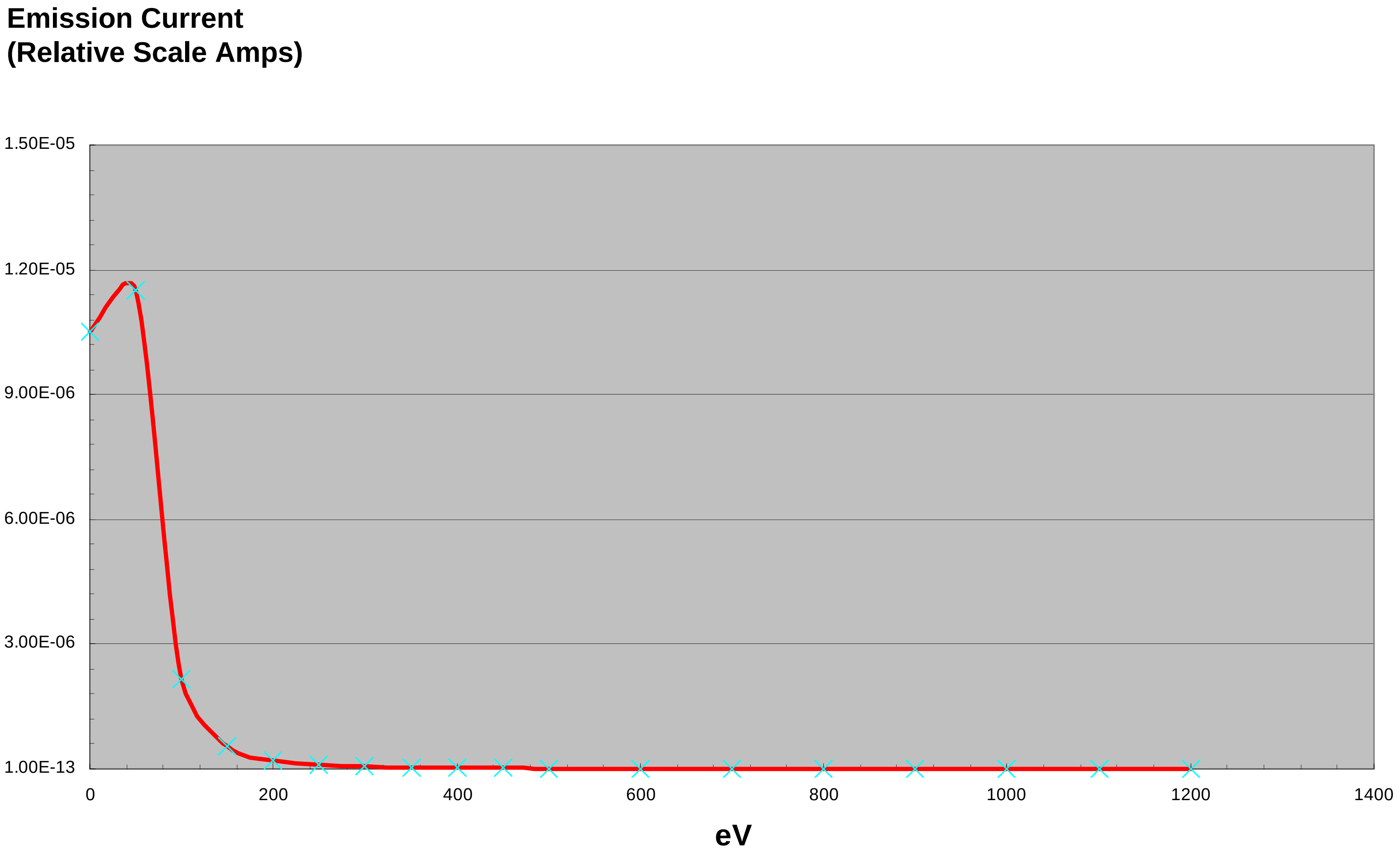
ELECTROGEN™ Turn-On Time



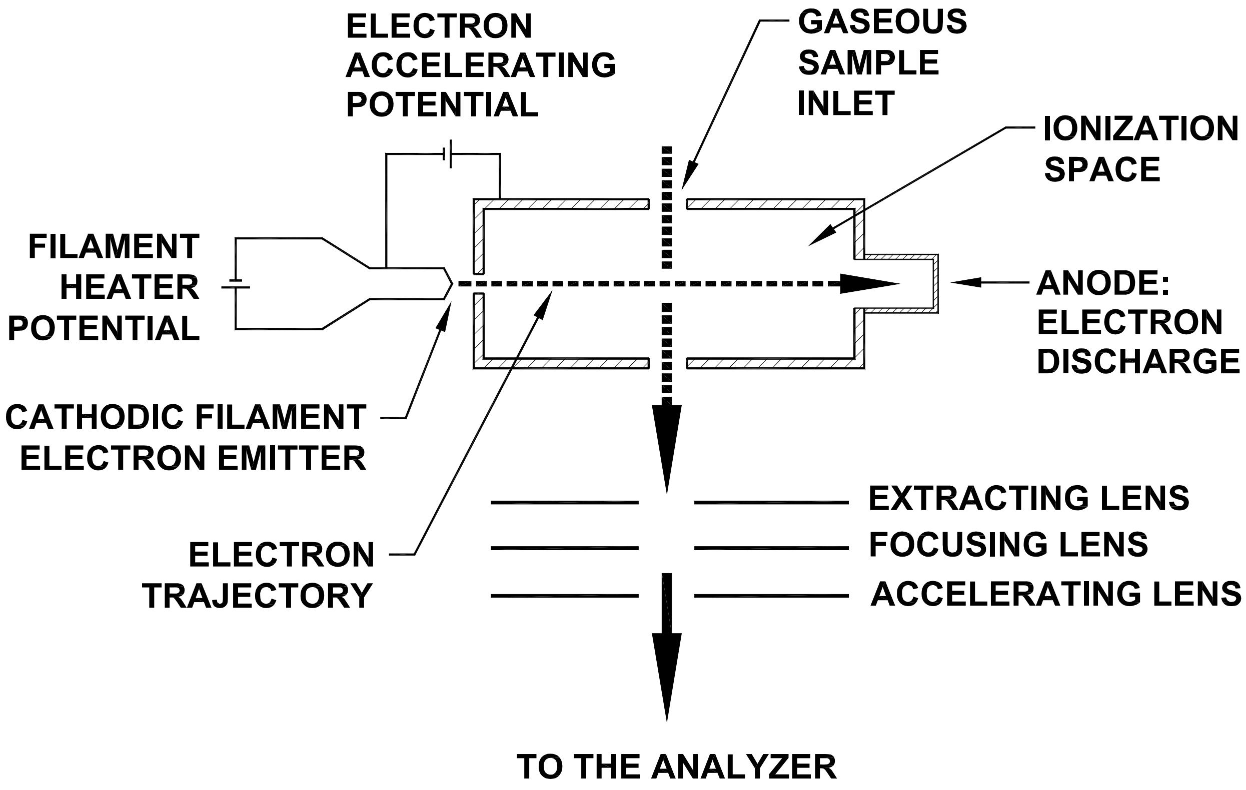
Energy Distribution of Emitted Electrons, Z-Stack Configuration



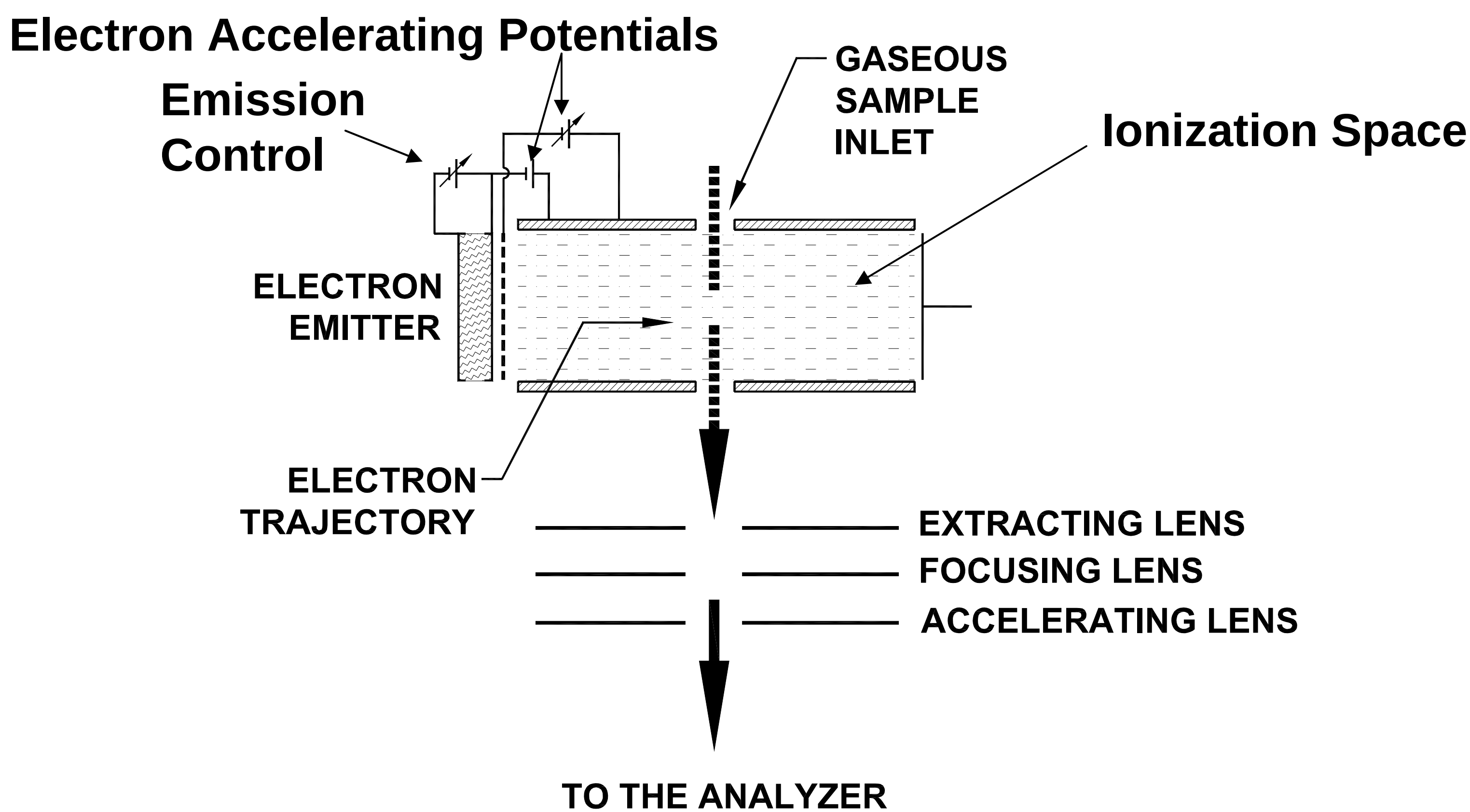
Common Ionization Methods

- Photo-Ionization
- Chemical Ionization
- Field Ionization
- Electron Impact

Conventional Electron Impact Ionization Source Configuration

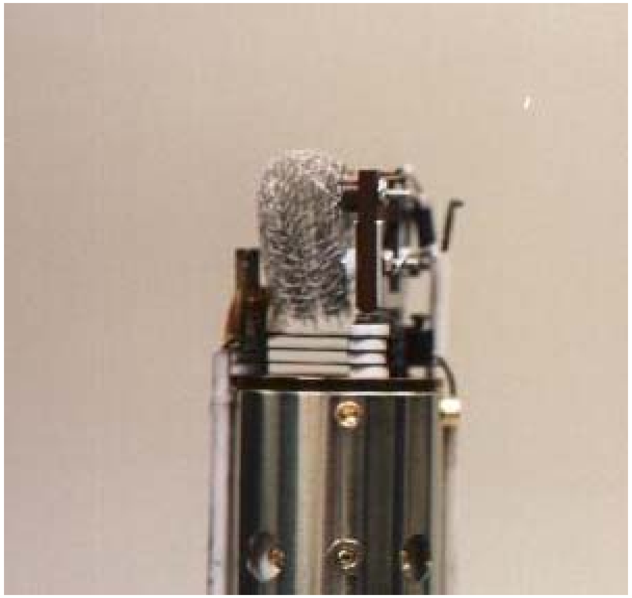


EGA Ionization Source Concept



Ion Sources

Conventional RGA Ion Source



EGA Prototype Ion Source

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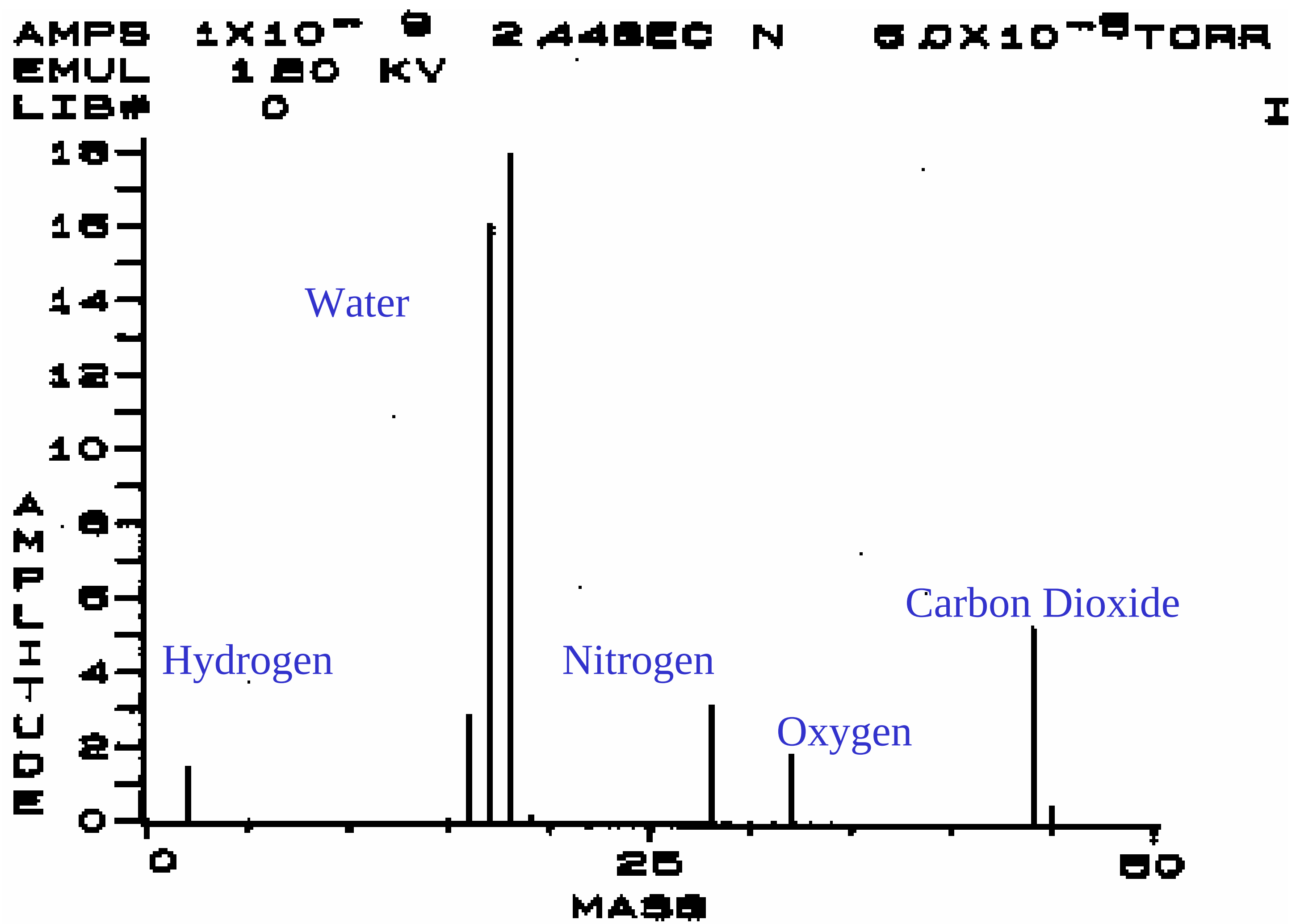
Residual Gas Analysis Taken With EGA Prototype Ion Source



ELECTROGEN™ Advantages I

- **“Cold” Ionization Source**
- **Large Emission Area**
- **Parallel Beam, Not Sensitive to Field Strength Changes**
- **High Density, Uniform Emission Pattern**
- **Fine Emission Level Control**
- **Won’t Burn Out, Durable**
- **No Photon Noise**

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ELECTROGEN™ Advantages II

- **Low Maintenance, Frequent Cleaning not Required Because Of Cold Ionization**
- **No Heat-Up/Stabilization Time Required**
- **Bi-Directional Emitter**
- **Low Power Consumption (e-gun 38 W vs. EGA 0.024 W)**
- **Simple Single Voltage Supply Design**
- **No Raster Scanning Electronics Required**

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ELECTROGEN™

Specifications

Emission Area	3 mm -150 mm dia
Electron Flux Density	0 to 50 $\mu A/cm^2$ (Tunable)
Power Supply Voltage	to 3600V Max
Current Required	44 mA Max.
Max Bake Temp	300°C
Max Operating Temp	200°C
Uniformity	10%