

5 eV to 1000 eV
Wide-Angle Low-Energy Electron Beams from a Compact Source

FOR USE IN:

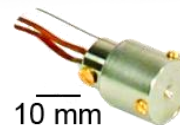
- Charge Neutralization
- Surface Physics Studies
- Ionization Experiments
- Surface Scrubbing

FEATURES / OPTIONS:

- Uniform Flood Beam
- Compact Design (13 mm diameter x 17 mm length)
- Variable Mounting Configurations
- Medium Currents at Low Energies
- Rebuildable Components
- Pulsing Options



*FRA-2X1-2 Electron Guns,
 Mounted on 2 3/4 CF*



*Standard FRA-2X1-2 Electron Gun, Unmounted
 (no CF Flange or Feedthrough)*

The Kimball Physics FRA-2X1-2 Electron Gun, with its matching EGPS-101 Power Supply, is intended for use in a variety of UHV surface physics, charge neutralization, and processing applications. It is a complete subsystem ready to attach to the user's vacuum system and turn on. Both beam energy and beam current are adjustable over wide ranges.

The FRA-2X1-2 Electron Gun uses a refractory metal cathode to generate a uniform flood beam. The cathode was specifically designed for low energy spread. The gun design allows for generation of the beam down to low energies, and very low currents. The FRA-2X1-2 can produce modest beam currents at energies as low as 5 eV. It can deliver maximum beam currents of 50 μ A at 5 eV, and 400 μ A at 1000 eV.

The FRA-2X1-2 low-energy electron flood gun uses a planar triode design. An acceleration grid enhances beam current at low energies. Secondary electrons, which may be generated at this grid, cannot exit the electron gun because of the positive potential (0 to +100 V with respect to the cathode) applied to the grid.

Enhanced in design for flood gun performance

at low energies, the FRA-2X1-2 Electron Gun has a half angle divergence at 50 eV of 11.5 degrees. As the beam energy is increased, the divergence decreases. Larger spots are achievable at low energies, but not necessarily at higher energies.

The standard FRA-2X1-2 Electron Gun is a compact unmounted gun with no feedthrough, as shown above. When part of a system with the EGPS-1011 Power Supply, this standard unmounted gun comes with a mounting kit (clamps, plates, and wire) and a separate flange and multi-pin feedthrough combination. Optionally the electron gun can be mounted on a 1.33" inch CF or 2.75" inch CF flange with a single multi-pin feedthrough (upper gun, above). The gun may also be mounted on a Flange Multiplexer for installation of a Faraday cup or to allow the grid wire lead to be separate for pulsing.

UHV technology is used throughout. The gun can be run in vacuums from 10^{-11} torr up to 10^{-5} torr for the standard Ta disc cathode. Unmounted, the electron gun is bakeable up to 400°C. Mounted on a feedthrough, it is bakeable up to 350°C with the cable removed. With

Faraday cup, maximum is 65°C unless removed.

The standard cathode is tantalum disc. Optional cathodes include: 1) barium oxide discs (BaO, low light, low energy spread, min. vacuum 1×10^{-7} torr) or 2) yttria-coated iridium discs (Y_2O_3 - Ir, rugged, vacuum up to 10^{-4} torr, may survive brief loss of vacuum). Except for BaO, the cathodes are not damaged by repeated exposure to atmospheric gases or water vapor when cold. Cathode lifetime is a function of vacuum conditions and beam current as related to cathode temperature. Cathode lifetime at low currents in good vacuum may be in the many hundreds of hours, or even over a thousand hours.

In the mounted gun, firing units are user-replaceable; spare firing units can be purchased new, or used firing units may be returned to the factory for rebuild. Alternatively, the entire mounted electron gun, or an unmounted gun, can be sent back to the factory for complete cleaning, rebuild, cathode replacement, and optional in-vacuum testing.

The extraction grid allows pulsing options: either fast capacitive beam pulsing or dual grid pulsing. Capacitive beam pulsing, using a Pulse Junction Box, permits fast beam pulsing down to 20 ns with 20% maximum duty cycle. Capacitive pulsing requires an external,

variable-voltage pulse generator (not included) and Flange Multiplexer mounting. Pulsing of the electron beam can also be accomplished with dual grid supplies (positive and negative) in the EGPS-1011, requiring only a TTL pulse input.

The EGPS-1011 Power Supply features a modular design with miniaturized power supply clusters, optically isolated signals, and the FlexPanel digital interface controller. The included power supplies are Beam Energy, floating Source/ECC and Grid supplies.

The FlexPanel provides a digital display screen and a keypad for programming control on the front panel. Rear panel connectors allow remote /computer control and metering of all gun power supplies. RS-232 and mini-USB serial ports and an analog input/output connector are included on standard power supply units. All common computer interface bus types can be accommodated, by use of appropriate digital to analog converters. RS-422/485 conversion is possible.

An optional LabVIEW™ computer program, designed for the FRA-2X1-2, is available for remote computer control and metering. Software is available in two options: 1) using National Instrument DAQ modules and the 50-pin connectors on the EGPS-1011, or 2) via a simple serial connector interface. The program provides a virtual panel of controls and real-time metering on the user's computer screen.



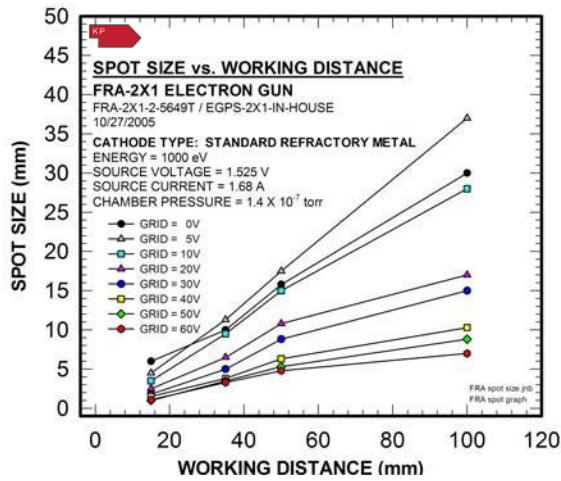
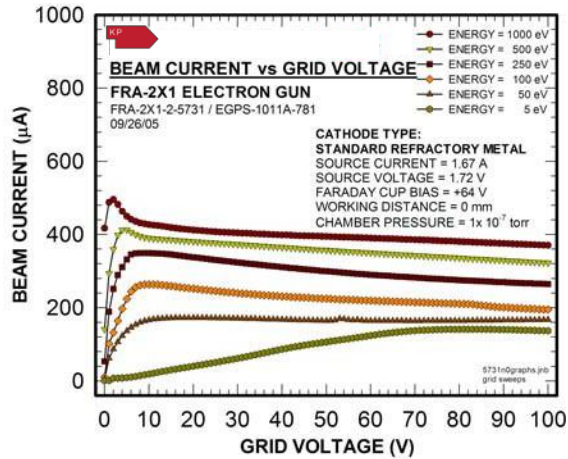
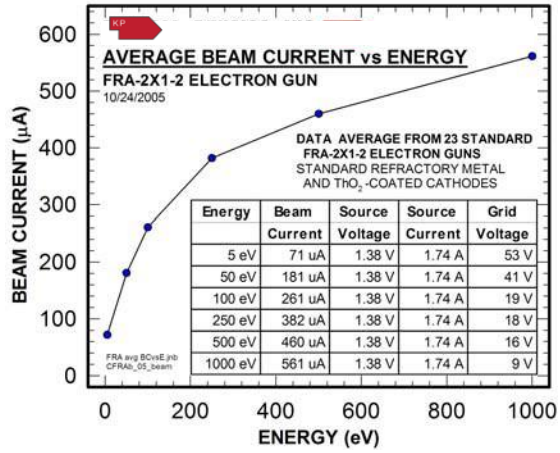
Front Panel EGPS-1011 Electron Gun Power Supply

FRA-2X1-2 ELECTRON GUN SPECIFICATIONS	
BEAM ENERGY	5 eV to 1000 eV (Independently adjustable)
BEAM CURRENT	1 nA to 400 μ A (Independently adjustable) with maximums of 50 μ A at 5 eV, 100 μ A at 50 eV, and 400 μ A at 1000 eV.
ENERGY SPREAD	Approx. cathode thermal spread, calculated Ta - 0.5eV Y ₂ O ₃ - 0.4eV BaO -0.3eV
SPOT SIZE	Flood beam: 2 mm to 50 mm. Spot size varies with beam parameters. Design optimized for 20 mm diameter spot size at 50 eV and 25 mm working distance.
WORKING DISTANCE	Variable: 10 mm to 50 mm
BEAM DEFLECTION	None
RASTER	None
PULSE CAPABILITY (using appropriate pulse generator, not included)	Optional Capacitive Pulse Junction Box: pulse width 20 ns to 100 μ s, rise/ fall 10 ns, 50 ohms impedance, 1 W standard (higher power available) Optional Dual Grid Power Supply: pulse width 2 μ s to DC, rise/ fall 500 ns, rep rates to 5kHz (TTL required)
BEAM BLANKING	None
BEAM UNIFORMITY	Gaussian
FIRING UNIT	For mounted gun: Customer-replaceable Firing Unit includes precision-aligned cathode and Wehnelt (G-1) assembly and anode, with insulators and connectors
CATHODE TYPE	Standard: Tantalum disc Optional: Barium oxide (BaO) or Yttrium oxide (Y ₂ O ₃) Except for Barium oxide, cathodes are not harmed by repeated exposure to atmospheric gases while cold
FARADAY CUP	Various stand-alone designs are available
MOUNTING	Standard: Unmounted— optional UHV mounting kit (SS plates, clamps, wire, CFF/feedthrough) Optional: Mounted—1 1/3" or 2 3/4 CFF with feedthrough or Flange Multiplexer with a 2 3/4 inch rotatable CFF, including both tapped and clear mounting holes
BEAM ALIGNMENT	Optional: Mechanical alignment with $\pm 2^\circ$ Port Aligner
INSERTION LENGTH	Unmounted: approximately 17.2 mm. Leads usually extend 90 mm beyond gun structure Mounted: Standard: 150 mm. Range: 110 to 170 mm. Custom lengths available. Gun manufactured at standard length unless otherwise specified at time of order.
GUN DIMENSIONS	Unmounted: 13.2 mm Mounted: 19.1 mm
FEEDTHROUGHS	Multi-pin brazed ceramic, threaded stainless steel shell
CABLES / CONNECTORS	Multi-conductor high voltage fully ground-shielded cable, with mating aluminum shell connectors, to connect gun and power supply. Standard lengths: 3 m Optional: 5 m (included with system, optional with unmounted gun)
MAXIMUM BAKEOUT	400°C Unmounted 350°C Mounted with cables removed 65°C max with Faraday cup (unless removed)

EGPS-1011 POWER SUPPLY SPECIFICATIONS	
OUTPUT	All necessary voltages to drive the FRA-2X1-2 Electron Gun
ENERGY SUPPLY STABILITY	$\pm 0.01\%$ per hour; $\pm 0.02\%$ per 8 hours at full output
BEAM STABILITY	$\pm 0.1\%$ per hour with Emission Current Control (ECC) or $\pm 10\%$ per hour after warm up without ECC
CONTROLS	FlexPanel controls: Energy, Source, Grid, Emission Current Control
METERING	FlexPanel digital meters: Energy, Source Voltage, Source Current, Emission Current, Grid
COMPUTER/REMOTE CONTROL & METER	Power supplies: 0 to +10 V Metering: 0 to +2 V Standard 50-pin connector for analog input/output and RS-232 and mini-USB serial port (RS-422 or RS-485 available, if specified at time of order)
SOFTWARE	Standard configuration designed for RS-232 and USB serial connections. Optional: National Instruments LabVIEW™ file, designed to run with NI DAQ modules
INPUT	115 VAC or 230 VAC, 50 to 60 Hz single phase, 250 VA
ENVIRONMENT	Temperature: 0 to 40°C, Relative humidity: 0 to 75% RH non-condensing, Classified as a pollution degree 2, installation category (overvoltage category) II environment unit
DIMENSIONS (width x height x depth)	17 in. x 3.5 in. x 22 in. excluding handles (425 mm x 90 mm x 560 mm); 19 in. rack mountable

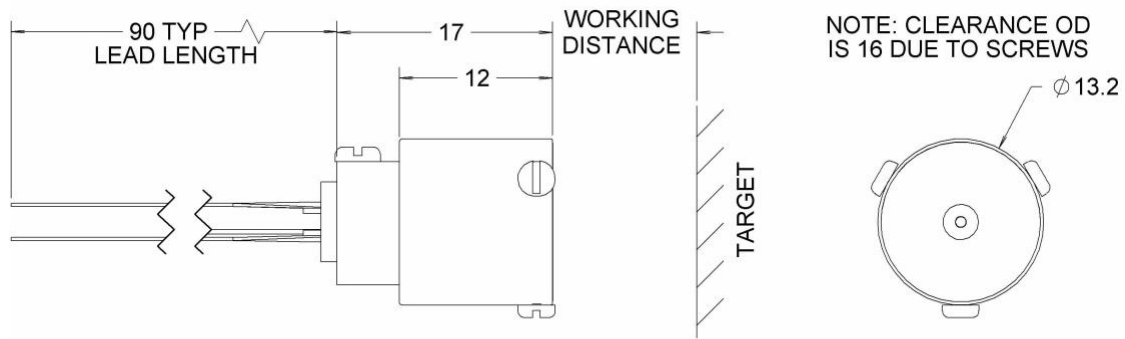


FRA-2X1-2 on a 2.75" CF Flange Multiplexer, with a rotary Faraday Cup





*Optional Mounting Kit
for an unmounted FRA-2X1-2 Electron Gun.*



UNMOUNTED FRA-2X1-2 ELECTRON GUN
(Dimensions in mm)

References

For more information on electron sources / gun operations (and the technical bulletins and additional documents listed below), please visit the Resources and Documents section of our website.

General Operating Hints

Operating Instructions, Typical LabVIEW™ Electron Gun Systems

Beam Pulsing Options

Note: A comprehensive custom manual is supplied with each system.

Notes:

1. Charts /graphs show typical performance, data is for guidance only.
2. It is not necessarily possible to achieve all maximum specifications simultaneously.
3. Specifications Subject to Change Without Notice.
4. DE Altobelli, DT Taylor 12/13/2022

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