Kimball Physics Electron Guns (Sources)

Introduction

Kimball Physics specializes in the design and manufacturing of precision high-tech scientific instruments, with over 50 years of experience in ultra-high-vacuum electron and ion optics. Our expertise is in high stability electron emitters, precision electrostatic and magnetostatic optics, along with state-of-the-art vacuum chambers and fittings. Our electron and ion systems are optimized for beam energies ranging from 1 eV to 100 keV and beam currents from femtoamperes to amperes.

Kimball Physics is a key supplier of electron guns / sources designed for use in a wide variety of ultra-high vacuum (UHV) surface physics applications, space physics, and processing applications, and numerous other applications that are provided below.

Guns can be focusable into small spot size, for use in applications such as x-ray production, welding and RHEED; or for flood beams, and use in charge neutralization, electron beam scrubbing, space simulation and radiation damage studies.

Kimball Physics products have evolved into broad range of electron source systems that we arbitrarily characterized as low energy (up to 5 keV), medium (up to 30 keV) and high (up to 100 keV) energy systems. Many of the systems were born from custom projects, which still is a large portion of our focus.

Please explore the pages that following to learn more about the range of operation, performance, convenience, and operating capabilities of our highly precise and reliable systems.

Please reach out to Kimball Physics for more information and to further discuss your custom applications.

RANGE OF OPERATION

- Energy Ranges: 1 eV to 100 keV
- Beam Current Ranges: 1 nA to 20 mA
- Spot Size Ranges: 15 µm (focused column) to 500+ mm (flood beams)

PERFORMANCE

- Beam Current Stability: feedback-stabilized emission current control; better than ± 0.1% per hour
- Energy Stability: ± 0.01% per hour, ± 0.02% per 8 hours at full output to minimize chromatic aberration

CONVENIENCE

- Customer-replaceable firing units
- Mechanical alignment during full operation
- Storable control settings
- Computer remote control / metering
- Dedicated Power Supplies

OPERATIONAL CAPABILITIES

- Fast pulsing / Beam blanking
- Deflection / Rastering
- Gun-mounted Faraday cups

ADVANCED ELECTRON OPTICS OPTIONS

- Electrostatic and Magnetostatic Focusing
- Octupole Deflection / Raster / Stigmator

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Overview Electron Gun Systems

Kimball Physics electron source / gun systems are typically provided with a matching power supply to provide a complete subsystem that is ready to attach to the user's vacuum hardware and turn on.

Beam energy, beam current and spot size on many systems are independently adjustable over their wide ranges and can be controlled with an optional Labview^{TM} computer interface.

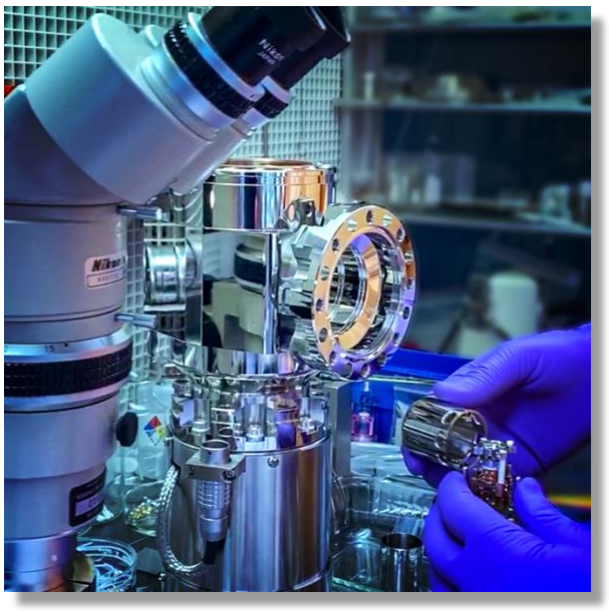
Most of our systems are UHV (ultra-high vacuum) compatible in vacuum conditions up 10^{-11} torr.

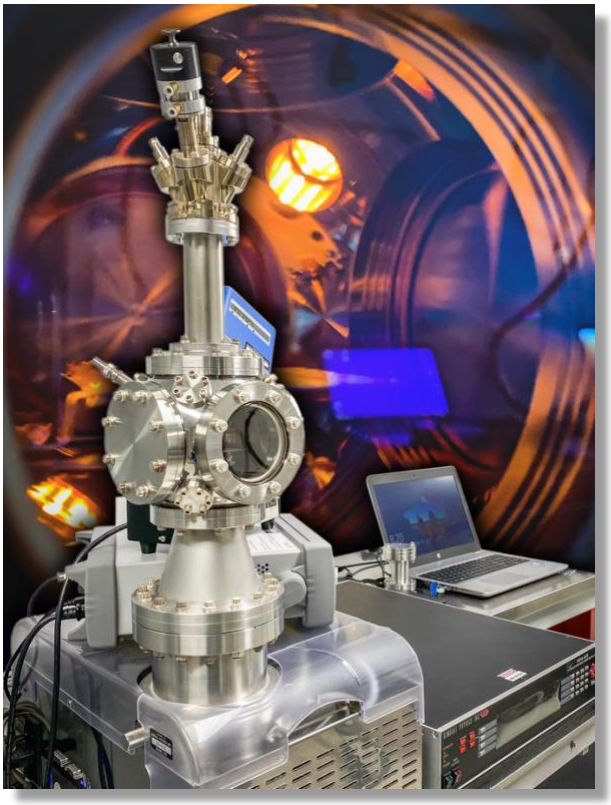
Depending on the system, various cathodes options are available and include: 1) barium oxide discs (BaO, low light, low energy spread, min. vacuum $1x10^{-7}$ torr), 2) yttria-coated iridium discs (Y_2O_3 Iridium, rugged, vacuum up to 10^{-4} torr, may survive brief loss of vacuum), 3) Tantalum disc cathodes, and 4) single-crystal lanthanum hexaboride (LaB_6, small spot, high brightness, min. vacuum $1x10^{-7}$ torr).

In many systems, firing units are modular and user-replaceable. They can also be sent back to Kimball Physics for rebuild and cathode replacements

More information about our photoemission and pulsing options, electron optics (focusing, deflection, shaping, stigmator, etc.), alignment during operation, computer/remote control and other options will be provided with the specific electron gun system's documentation.

In the sections below, we provide a summary of the features in our low, medium, and high energy electron gun systems. We also provide numerous tables to help you compare the various design features to allow to choose the system for your application. Detailed system documents are available for each gun system with detailed specifications, drawings, solid models, and more detailed descriptions.





Upper Figure: Assembly, in progress, of an electron gun system. Lower Figure: Electron Gun System with electron gun, MCF vacuum chamber, vacuum pump, power supply, and laptop for Labview^{TM} computer control interface. Image background is based on a typical view inside the chamber during operation.

Low Energy Electron Gun Systems

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Kimball Physics has several low energy electron systems with energy up to 5 keV. We provide a

summary of each system below. Please also refer to the charts below to compare features and the References at the end of the document to access the complete electron gun system documents.

FRA-2X1-2/EPGS-1011 System

The Kimball Physics FRA-2X1-2 Electron Gun, with its matching EGPS-1011 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 µA at 5 eV, and 400 µA at 1000 eV.

ELG-2 / EGPS-1022 System

The Kimball Physics ELG-2 Electron Gun, with its matching EGPS-1022 Power Supply, is intended for use in electron stimulated desorption studies, secondary electron emission coefficient measurement studies, surface physics and other vacuum physics studies. It is a complete subsystem ready to attach and turn on.

Beam energy, beam current and spot size are independently adjustable over wide ranges. The energy is variable from 1 eV to 2000 eV, with a low range included for improved resolution at the lowest energies. By use of multi-staging and a computer-designed electron zoom lens, a constant beam current is maintained over a two order-of-magnitude change in energy, with a spot size also roughly constant. The gun can deliver 1 µA into an approximately 1 mm spot, at a 2 cm working distance and 10 eV. The electron gun uses a unipotential refractory cathode to generate a beam of low energy spread.

EGA-1012 / EGPS_1012

The Kimball Physics EGA-1012 Electron Gun, with its matching EGPS-1012 Power Supply, is intended for use in a variety of UHV, surface physics, and processing applications where high beam currents are needed at low energy. It is a complete subsystem ready to attach and turn on.

Beam energy, beam current and beam divergence are all independently adjustable. The EGA-1012 Electron Gun uses a space-charge-limited oxide-coated cathode to generate a uniform flood beam.

EFG-7 / EGPS_1017

The Kimball Physics EFG-7 Electron Gun, with its matching EGPS-1017 Power Supply, is intended for use in a variety of UHV, surface physics, and processing applications. It is a complete subsystem ready to attach and turn on. Beam energy, beam current and spot size are independently adjustable over wide ranges.

The EFG-7 Electron Gun uses a refractory metal cathode to generate a uniform flood beam. The gun design allows for generation of the beam down to low energies, and very low currents. The standard model EFG-7 produces a beam current of 1 nA to 100 µA and energies of 10 eV to 1500 eV. A High Current option provides beam currents up to 1 mA.

Centering deflection, rastering and pulsing are all available as options. Because the design has been optimized as a flood gun and uses a cylindrical 4-pole deflector, deflection aberrations can be severe when the beam is focused into a small spot.

EFG-7 / EGPS_2017

The Kimball Physics 5 keV EFG-7 Electron Gun, with its matching EGPS-2017 Power Supply, is intended for use in a variety of UHV, surface physics, and processing applications. It is a complete subsystem ready to attach and turn on. Beam energy, beam current and spot size are independently adjustable over wide ranges.

The EFG-7 Electron Gun uses a refractory metal cathode to generate a uniform flood beam. The gun design allows for generation of the beam down to low energies, and very low currents. The 5 keV model EFG-7 produces a beam current of 1 nA to 100 µA and energies of 50 eV to 5 keV.

Centering deflection, rastering and pulsing are all available as options. Because the design has been optimized as a flood gun and uses a cylindrical 4-pole deflector, deflection aberrations can be severe when the beam is focused into a small spot.

EGL-2022 / EGPS-2022 System

The Kimball Physics EGL-2022 Electron Gun, with its matching EGPS-2022 Power Supply, has applications in a variety of surface physics, ionization, charge neutralization, and other vacuum physics studies. It is a complete subsystem ready to attach and turn on.

Beam energy, beam current, and spot size are independently adjustable over wide ranges. The energy is variable from 50 eV to 5 keV, and the beam current from 1 nA to 100 µA. By use of multi-staging and a computer-designed electron zoom lens, a constant beam current is maintained over a two-order-of-magnitude change in energy, with a spot size also roughly constant. The electron gun uses a unipotential cathode to generate a beam of low energy spread.

The gun design can include a positively biased acceleration grid to enhance emission and collimate the beam. A negative potential is typically applied to this grid element to collimate the beam, suppress emission, and cut off the beam.

Electron Guns Systems- Low Energy Range (<5 keV)

Electron Gun System	Range	Beam Energy	Beam Current	Spot Size	Working Distance	Beam Uniformity
FRA-2X1-2 EGPS-1011	Min	5 eV	1 nA	2 mm	10 mm	Gaussian
	Max	1 keV	400 µA	50 mm	50 mm	
ELG-2 EGPS-1022	Min	1 eV	1 nA	0.5 mm	5 mm	Gaussian
	Max	2 keV	10 µA	5 mm	100 mm	
EGA-1012 EGPS-1012	Min	5 eV	1µA	10 mm	25 mm	
	Max	1 keV	2 mA	25 mm	200 mm	
EFG-7 EGPS-1017	Min	10 eV	1 nA	1 mm	25 mm	Gaussian or Uniform
	Max	1.5 keV	100 µA	100 mm	200 mm	
EFG-7 (High Current) EGPS-1017	Min	10 eV	1nA	1 mm	25 mm	Gaussian or Uniform
	Max	1.5 keV	1mA	100 mm	200 mm	
EFG-7 EGPS-2017	Min	50 eV	1 nA	1 mm	25 mm	Gaussian or Uniform
	Max	5 keV	100 µA	100 mm	200 mm	
EGL-2022 EGPS-2022	Min	50 eV	1 nA	1 mm	20 mm	Gaussian
	Max	5 keV	100 µA	10 mm	100 mm	

Electron Gun Systems- Low Energy Range (<5 keV)

Electron Gun System		Applications	Features
FRA-2X1-2 **EGPS-1011**		• Charge Neutralization • Surface Physics Studies • Ionization Experiments • Surface Scrubbing	**5 eV to 1000 eV** • Wide Angle Low Energy Electron Beam • Medium Currents at Low Energies • Compact Size • Variable Mounting Configuration • Rebuildable Components
ELG-2 **EGPS-1022**		• Surface Physics Studies • Electron Stimulated Desorption • Inverse photoelectron Emission • Ionization Experiments • Charge Neutralization	1**eV to 2000 eV** • Wide Energy Range • Very Low Energies • Constant Beam Current • Constant Spot Size • Zoom Lens Focusing • Demountable Gun • High Speed Pulsing • Deflection, Rastering • Computer/Remote Control
EGA-1012 **EGPS-1012**		• Surface Physics Studies • Vacuum Physics Experiments • Charge Neutralization • Electron Desorption • Surface Scrubbing • Phosphor Testing • Ionization Experiments • Semiconductor Processing	**5 eV to 1000 eV** • High Beam Current (up to 2 mA) at Low Energy • Flood Beam (uniform) • Feedback stabilized emission current • Low energy, low current beams
EFG-7 **EGPS-1017**		• Surface Physics Studies • Vacuum Physics Experiments • Charge Neutralization • Electron Desorption • Surface Scrubbing • Phosphor Testing • Ionization Experiments • Semiconductor Processing	**10 eV to 1500 eV** • Standard: 1 nA to 100 μA (Independently adjustable) • Widely Controllable Parameters • Flood Beams or Narrow Angle Beams • Electrostatic Focusing • Deflection, Rastering, Pulsing • Demountable Gun • Computer / Remote Control

Electron Gun Systems- Low Energy Range (<5 keV), continued

EFG-7 (High Current) EGPS-1017		• Surface Physics Studies • Vacuum Physics Experiments • Charge Neutralization • Electron Desorption • Surface Scrubbing • Phosphor Testing • Ionization Experiments • Semiconductor Processing	**10 eV to 1500 eV** • High Current option: 1 nA to 1 mA • Widely Controllable Parameters • Flood Beams or Narrow Angle Beams • Electrostatic Focusing • Deflection, Rastering, Pulsing • Demountable Gun • Computer / Remote Control
EFG-7 EGPS-2017		• Surface Physics Studies • Vacuum Physics Experiments • Charge Neutralization • Electron Desorption • Surface Scrubbing • Phosphor Testing • Ionization Experiments • Semiconductor Processing	**50 eV to 5 keV** • High Current option: 1 nA to 1 mA • Widely Controllable Parameters • Flood Beams or Narrow Angle Beams • Electrostatic Focusing • Deflection, Rastering, Pulsing • Demountable Gun • Computer / Remote Control
EGL-2022 EGPS-2022		• Surface Physics Studies • Ionization Experiments • Charge Neutralization	**50 eV to 5 keV** • Energy Sweeping • Constant Current and Approximately Constant Spot Size • Wide Energy Range • Constant Beam Current • Constant Spot Size • Zoom Lens Focusing • High Speed Pulsing • Deflection, Rastering • Computer / Remote Control

Medium Energy Electron Gun Systems

Kimball Physics has several medium energy electron systems with energy up to 30 keV. We provide a summary of each system below. Please also refer to the charts below to compare features and the references to access the complete electron gun system documents.

EGG-3101 / EGPS-3101 System

The Kimball Physics EGG-3101 Electron Gun, with its matching EGPS-3101 Power Supply, is a multi-purpose modular Electron Gun with applications many areas. The EGG-3101 / EGPS-3101 is a complete subsystem ready to attach to a user's vacuum system and turn on.

With a small spot option using a lanthanum hexaboride cathode, the gun can deliver spots down to 60 µm. With a high current option, beam currents up to 1 mA can be obtained. The gun has the capability of producing a collimated small spot or a flood electron beam.

Beam current, beam energy, and spot size are all independently adjustable over wide ranges. The energy can be varied from 100 eV to 10 keV. The beam current and spot size range depend

on the system option as shown in the specifications table. Pulsing, beam blanking and rastering are also available as options.

EGG-3103 / EGPS-3103 System

The Kimball Physics EGG-3103 Electron Gun, with its matching EGPS-3103 Power Supply is a medium energy, high current electron gun with applications in general vacuum physics, surface heating, excitation, ionization, fluorescence experiments, and spacecraft testing. It is a complete subsystem ready to attach and turn on.

The gun generally uses an Yttria (Y_2O_3) cathode to generate a high current, focusable electron beam. The gun has a Pierce style geometry with a shaped grid element and a shaped first anode element to control the beam. Both beam energy and beam current are independently adjustable over wide ranges. The energy is variable from 100 eV to 10 keV, and current from 200 µA to 10 mA. A high current option provides beam currents up to 50 mA.

EGG-3104 / EGPS-3104 System

The Kimball Physics EGF-3104 Electron Gun, with its matching EGPS-3104 Power Supply, is intended for use in a variety of UHV charging, space physics, vacuum physics, surface physics, and nuclear simulation applications. It is a complete subsystem ready to attach and turn on. Maximum flexibility is achieved in a minimum of space; the entire unit mounts through a single standard 2.75” inch CF port.

Electrons are generated at negative high potential, and the user’s target is typically set at ground potential. Both beam energy and beam current are adjustable over wide ranges. The gun uses a space charge-limited refractory-metal cathode to generate a uniform flood beam and the design allows generation of the beam down to low energies, and very low currents. A high current option provides beam currents up to 1 mA. Beam divergence is partially controllable electronically over the full range of the electron energy.

EMG-4212 / EGPS-3212 System

The Kimball Physics EMG-4212 Electron Gun, with its matching EGPS-3212 Power Supply, is a multi-purpose modular Electron Gun with applications in many areas. It is a complete subsystem ready to attach to a user's vacuum system and turn on. The gun has the capability of producing a collimated, small spot or flood electron beam.

Beam current, beam divergence, and beam energy are all adjustable over wide ranges. The energy can be varied from 1 keV to 20 keV. The beam current and spot size range depend on the system option as shown in the table below. With the standard cathodes, the beam current is independently adjustable from 1 nA to 100 µA. With a small spot option using a lanthanum hexaboride cathode, the gun can deliver spots down to 100 µm. With a high current option, beam currents up to 1 mA can be obtained.

EMG-4212 / EGPS-4212 System

The Kimball Physics EMG-4212 Electron Gun, with its matching EGPS-4212 Power Supply, is a multi-purpose modular Electron Gun with applications in many areas. The EMG-4212/ EGPS-4212 is a complete subsystem ready to attach to a user's vacuum system and turn on. The gun has the capability of producing a collimated, small spot or flood electron beam.

Beam current, beam divergence, and beam energy are all adjustable over wide ranges. The energy can be varied from 1 keV to 30 keV. The beam current and spot size range depend on the system option as shown in the table below. With the various refractory metal disc cathodes, the beam current is independently adjustable from 1 nA to 100 µA. With a small spot option using a lanthanum hexaboride cathode, the gun can deliver spots down to 100 µm. With a high current option, *beam currents up to 1 mA can be obtained*. Rastering is also available as an option.

EMG-4215 / EGPS-4215 System

The Kimball Physics EMG-4215 Electron Gun, with its matching EGPS-4215 Power Supply, is a multi-purpose modular Electron Gun with applications in many areas. The EMG-4215/ EGPS-4215 is a complete subsystem ready to attach to a user's vacuum system and turn on. The gun has the capability of producing a collimated, small spot or flood electron beam.

Beam current, beam divergence, and beam energy are all adjustable over wide ranges. The energy can be varied from 1 keV to 30 keV. With the lanthanum hexaboride cathode, the beam current is independently adjustable from 1 nA to 5 mA. The gun can deliver spots down to 500 µm. Rastering is also available as an option.

EGF-4210 / EGPS-4210 System

The Kimball Physics EMG-4210 Electron Gun with its matching EGPS-4210 Power Supply is a complete subsystem ready to attach to the user's vacuum system and turn on. It can deliver electrons over a very broad range of energies, currents, and power. The EMG-4210 has applications in space materials testing, radiation studies, semiconductor research, x-ray generation and plasma excitation.

The gun uses a single-crystal lanthanum hexaboride (LaB_6) cathode to generate a high energy, focusable, small spot electron beam. Both beam energy and beam current are independently adjustable over wide ranges, the energy from 1 keV to 30 keV, and current from 10 µA to 5 mA. The electron beam can be pulsed by an input signal to the control grid.

The adjustable optics of the gun can adapt to different divergences and a range of working distances, suitable to a variety of applications. The magnetic focusing lens can vary the spot size from 10 mm down to 100 µm. The magnetic centering and optional shaping coils provide additional beam control, allowing the user to deflect and shape the electron beam. Shaping typically results in an elliptical beam, both axes of which can be independently compressed or extended. In addition, the cathode to anode spacing is internally adjustable to change perveance.

EMG-4193 / EGPS-4190 COPS-4190 System

The Kimball Physics EMG-4193 Electron Gun, with its matching EGPS-4190 Power Supply and COPS-4190 Column Optics Unit is a medium power Electron Gun for surface physics applications and general vacuum physics research. It is a complete subsystem ready to attach and turn on.

Both beam current and beam energy are independently adjustable over wide ranges; the energy from 1 keV to 30 keV, and current from 1 nA to 10 µA. The beam divergence is also directly controllable.

The gun uses a lanthanum hexaboride (LaB_6) cathode to provide a small spot, down to 25 µm. A constant emission can be maintained by a control grid which is varied electronic feedback. The LaB_6 cathode can have a lifetime in the thousands of hours. The beam is rastered for imaging of the target.

The gun's adjustable optics include two focusing lenses as well as three quadrupole alignment and two octupole deflection elements. The gun also features an adjustable feedthrough assembly that allows mechanical alignment of the firing unit while the gun is being operated.

The gun has a blanker element which diverts the electron beam into an in-line Faraday cup. This system is used to measure the beam current in the column. The blanker provides a means of cutting off the beam while the gun is running and could also be used for pulsing.

ELG-7 Low Energy Electron Gun

Electron Gun Systems (Medium Energy: up to 30keV)

Electron Gun System	Range	Beam Energy	Beam Current	Spot Size	Working Distance	Beam Uniformity
EGG-3101 EGPS-3101	Min	100 eV	10 nA	0.5 mm	10 mm	Gaussian
	Max	10 keV	100 uA	25 mm	1000 mm	
Small Spot	Min		1 nA	60 µm		
	Max		10 uA	10 mm		
High Current	Min		1 uA	1.5 mm		
	Max		1 mA	25 mm		
EGG-3103 EGPS-3103	Min	100 eV	200 µA	1.5 mm	100 mm	Gaussian
	Max	10 keV	10 mA	20 mm	1000 mm	
High Current	Min		5 mA	5 mm		
	Max		50 mA	25 mm		
EGF-3104 EGPS-3104	Min	200 eV	1 nA	15 mm	Variable	Variable
	Max	20 keV	100 µA	450 mm		
High Current	Min		10 nA	15 mm	Variable	
	Max		1 mA	450 mm		
EMG-4212 EGPS-3212	Min	1 keV	10 nA	0.5 mm	100 mm	Gaussian
	Max	20 keV	100 µA	25 mm	1000 mm	
Small Spot	Min		1 nA	100 µm		
	Max		10 µA	10 mm		
High Current	Min		1 µA	1.5 mm		
	Max		1 mA	25 mm		
EMG-4212 EGPS-4212	Min	1 keV	10 nA	0.5 mm	100 mm	Gaussian
	Max	30 keV	100 µA	25 mm	1000 mm	
Small Spot	Min		1 nA	100 µm		
	Max		10 µA	10 mm		
High Current	Min		1 µA	1.5 mm		
	Max		1 mA	25 mm		
EMG-4215 EGPS-4215	Min	1 keV	1 nA	0.5 mm	100 mm	Gaussian
	Max	30 keV	5 mA	25 mm	1000 mm	
EGF-4104 EGPS-4104	Min	200 eV	1 nA	15 mm	100 mm	Variable
	Max	30 keV	100 µA	450 mm	1000 mm	
High Current	Min		10 nA	15 mm		
	Max		1 mA	450 mm		
EMG-4210 EGPS-4210	Min	1 keV	10 µA	100 µm	50 mm	Gaussian
	Max	30 keV	5 mA	10 mm	1000 mm	
EMG-4193 EGPS-4190	Min	1 keV	1 nA	25 µm	30 mm	Gaussian
	Max	30 keV	10 µA	500 µm	200 mm	

Electron Gun System Features (Medium Energy <30 keV)

Electron Gun System		Applications	Features
EGG-3101 **EGPS-3101**		• General Vacuum Physics Experiments • Space Physics Experiments • Specimen Heating • Electron Diffraction • Phosphor Studies • MBE RHEED Studies	**100 eV to 10 keV** • Small Spot Collimated Beam • New Modular Design • Internal Alignment while operating • Collimated Beam • Small Spot Option down to 60 µm • Higher Current Option up to 1 mA • Electrostatic Focus and Deflection • Blanking, Pulsing, Rastering • Rotatable 2.75” inch CFF Mounting • UHV compatible and bakeable • Computer / Remote Control • Flange Multiplexer Flexibility • User-replaceable Firing Units
EGG-3103 **EGPS-3103**		• Neutral Beam Excitation • Space Physics Studies • Surface Heating • Surface Excitation • Fluorescence Experiments • Spacecraft Testing • Vacuum Physics Experiments	**100 eV to 10 keV** • Beam Currents to 50 mA • Focusing, Deflection and Rastering • 2.75” inch CF Mounting • Computer / Remote Control
EGF-3104 **EGPS-3104**		• Spacecraft Charge-up Studies • Surface Charging Studies • Beta Decay Simulation • Surface Physics Studies • Vacuum Physics Experiments	**200 eV to 20 keV** • Uniform Flood Electron Beam • Energy Range 200 eV to 20 keV • Beam Currents to 1 mA • Wide Angle Uniform Beam • Divergence Control • Rotatable 2 ¾ CF Mounting • User-replaceable Firing Units • Computer / Remote Control • Custom Apertures
EMG-4212 **EGPS-3212**		• MBE RHEED Studies • Electron Diffraction • Space Physics Studies • Gas Electron Fluorescence • X-ray Generation • Heating / Melting / Welding • Vacuum Physics Experiments	**1 keV to 20 keV** • Small Spot Collimated Beam • New Modular Design • Internal Alignment while operating • Collimated Beam • Small Spot Option down to 100 µm • Higher Current Option up to 1 mA • Electrostatic Focus and Deflection • User Replaceable Firing Units • UHV compatible and bakeable • Computer / Remote Control • Beam Pulsing and Blanking Options

Electron Gun System Features (Medium Energy <30 keV), continued

EMG-4212 **EGPS-4212**		• MBE RHEED Studies • Electron Diffraction • Space Physics Studies • Gas Electron Fluorescence • X-ray Generation • Heating / Melting / Welding • Vacuum Physics Experiments	**1 keV to 30 keV** • Small Spot Collimated Beam • New Modular Design • Internal Alignment while operating • Collimated Beam • Small Spot Option down to 100 µm • Higher Current Option up to 1 mA • Electrostatic Focus and Deflection • User Replaceable Firing Units • UHV compatible and bakeable • Computer / Remote Control • Beam Pulsing and Blanking Options
EMG-4215 **EGPS-4215**		• MBE RHEED Studies • Electron Diffraction • Space Physics Studies • Gas Electron Fluorescence • X-ray Generation • Heating / Melting / Welding • Vacuum Physics Experiments	**1 keV to 30 keV** • High Current Density • New Modular Design • Internal Alignment while Operating • Collimated Beam • Spot Size down to 500 µm • Medium Current Beams to 5 mA • Electrostatic Focus and Deflection • UHV Compatible and Bakeable • Computer / Remote Control • User-replaceable Firing Units
EGF-4104 **EGPS-4104**		• Spacecraft Charge-up Studies • Surface Charging Studies • Beta Decay Stimulation • Surface Physics Studies • Vacuum Physics Experiments	**200 eV to 30 keV** • Energy Range: 200 eV to 30 keV • Beam Currents to 1 mA • Wide Angle Uniform Beam • Divergence Control • Rotatable 2 ¾ CF Mounting • User-Replaceable Firing Units • Computer / Remote Control • Custom Apertures
EMG-4210 **EGPS-4210**		• General Vacuum Physics • Radiation Studies • Surface Bombardment • Semiconductor Research • X-ray Generation • Plasma Excitation • Fluorescence Studies • Surface Physics Studies	**1 keV to 30 keV** • Focusable • Spot Size down to 100 µm • Beam Currents up to 5 mA • Magnetostatic Focusing • Optional Magnetostatic Beam Shaping • Magnetostatic Deflection • Pulse Capability • Internal Alignment while operating • User-replaceable Firing Units

Electron Gun System Features (Medium Energy <30 keV), continued

EMG-4193 **EGPS-4190** **COPS-4190**		• Surface Physics • Vacuum Physics Experiments	**1 keV to 30 keV** • Small Spot Size Electron Beams • New Modular Design • Photo Emission Option • Internal Alignment While Operating • Electrostatic Focusing • Quadrupole Alignment • Octopole Deflection / Raster / Stigmator • Beam Blanking • Inline Faraday Cup • Internal Magnetic Shielding • Differential pumping • Small Spot Down To 25 µm • Beam Current 1 nA to 10 uA • UHV Compatible / Bakeable • Computer /Remote Control • User-Replaceable Firing Units

High Energy Electron Gun Systems

Kimball Physics has several high energy electron systems with energy up to 100 keV. We provide a summary of each system below. Please also refer to the charts below to compare features and the references to access the complete electron gun system documents.

EGH-6210 / EGPS-6210 System

The Kimball Physics EGH-6210 Electron Gun with its matching EGPS-6210 Power Supply is a complete subsystem ready to attach to the user's vacuum system and turn on. It can deliver electrons over a very broad range of energies, currents, and power. The EGH-6210 has applications in space materials testing, radiation studies, semiconductor research, x-ray generation and plasma excitation.

The gun uses a single-crystal lanthanum hexaboride (LaB_6) cathode to generate a high energy, focusable, small spot electron beam. Both beam energy and beam current are independently adjustable over wide ranges, the energy from 1 keV to 60 keV, and current from 10 µA to 5 mA. The electron beam can be pulsed by an input signal to the control grid.

The adjustable optics of the gun can adapt to different divergences and a range of working distances, suitable to a variety of applications. The magnetic focusing lens can vary the spot size from 10 mm down to 50 µm. The magnetic centering and optional shaping coils provide additional beam control, allowing the user to deflect and shape the electron beam. Shaping typically results in an elliptical beam, both axes of which can be independently compressed or extended. The magnetostatic focusing lens and the deflection / shaping quadrupole both produce results with low aberration. In addition, the cathode to anode spacing is internally adjustable to change perveance.

EGH-6002 / EGPS-6002 System

The Kimball Physics EGH-6002 Electron Gun with its matching EGPS-6002 Power Supply is a complete subsystem ready to attach to the user's vacuum system and turn on. It can deliver electrons over a very broad range of energies, currents, and power.

The EGH-6002 can be used in many different applications from semiconductor research to secondary electron emission studies. The gun can generate a high energy, focusable, small spot electron beam. Both beam energy and beam current are independently adjustable over wide ranges; energies from 1 keV to 50 keV and currents from 10nA to 100μA are standard. The electron beam can be pulsed by an input signal to the control grid.

The adjustable optics of the gun can adapt to different divergences and different working distances. The spot size can be varied from 0.5 mm to 10 cm. A magnetic focusing lens and magnetic centering deflection provide beam control with low aberration. In addition, the cathode to anode spacing is internally adjustable to change perveance

EGF-6104 / EGPS-6104 System

The Kimball Physics EGF-6104 Electron Gun, with its matching EGPS-6104 Power Supply, is intended for use in a variety of UHV charging, space physics, vacuum physics, surface physics, and nuclear simulation applications. Maximum flexibility is achieved in a minimum of space; the entire unit mounts through a single standard 2.75" inch CF port. It is a complete subsystem ready to attach and turn on.

Electrons are generated at negative high potential; thus, the user's target is set at ground potential. Both beam energy and beam current are adjustable over wide ranges. The gun uses a space-charge-limited refractory-metal cathode to generate a uniform flood beam and the design allows generation of the beam down to low energies, and very low currents. Beam divergence is partially controllable electronically and can be mechanically limited with optional apertures. Standard model beam current is 200 μA. With a high current option, beam currents up to 5 mA can be obtained. The EGF-6104 utilizes optional 4-pole magnetic deflection to position and improve in beam current uniformity.

EGF-6115 / EGPS-6115 System

No longer available. Please now refer to Electron Gun System EGF-6104 / EGPS-6104 for similar specifications.

The Kimball Physics EGF-6115 Electron Gun with its matching EGPS-6115 Power Supply is a complete subsystem ready to attach to the user's vacuum system and turn on. It can deliver electrons over a broad range of energies, currents, and power. The EGH-6115 is a high power, focusable flood gun for use in spacecraft materials testing and other surface physics and general vacuum physics applications.

The gun can generate a high energy, adjustable divergence, flood electron beam. Both beam energy and beam current are independently adjustable over wide ranges; energies from 1 keV to 50 keV and currents from picoamps to five milliamps can be achieved. The electron beam can be pulsed by an input signal to the control grid.

The adjustable optics of the gun can adapt to different divergences and different working distances. Rastering / beam washing is used to provide a large uniform spot. Electrostatic focusing provides control of the spot size, which is typically in the tens of centimeters. The flood beam is also partially dependent on the grid, anode and working distance.

EGF-8100 / EGPS-8100 System

The Kimball Physics EGH-8100 Electron Gun with its matching EGPS-8100 Power Supply is a complete subsystem ready to attach to the user's vacuum system and turn on. It can deliver electrons over a very broad range of energies, currents, and power. The EGH-8100 has applications in space materials testing, radiation studies, semiconductor research x-ray generation and plasma excitation.

The gun uses a refractory metal or lanthanum hexaboride (LaB_6) cathode to generate a high energy, high current electron beam. Both beam energy and beam current are independently adjustable over wide ranges, the energy from 1 keV to 100 keV, and current from 10 nA to 1 mA. (20 mA pulsed). The electron beam can be pulsed by an input signal to the control grid.

EGF-8105 / EGPS-8105 System

The Kimball Physics EGH-8105 Electron Gun with its matching EGPS-8105 Power Supply is a complete subsystem ready to attach to the user's vacuum system and turn on. It can deliver electrons over a broad range of energies, currents, and power. The EGH-8105 is a high power, focusable flood gun for use in spacecraft materials testing and other surface physics and general vacuum physics applications.

This is a high energy, focusable, flood electron beam system where both beam energy and beam current are independently adjustable over wide ranges. Energies from 1 keV to 100 keV and currents from picoamps to a milliamp can be achieved. The electron beam can be pulsed by an input signal to the control grid.

The adjustable optics of the gun can adapt to different divergences and different working distances. A magnetic beam washing option is available which provides significant improvement in beam uniformity. An electrostatic focusing lens provides control of the spot size, which is typically in the tens of centimeters. However, as a flood-style gun, the spot size is also partially dependent on the grid, anode and working distance

EGF-8103 / EGPS-8103 System

The Kimball Physics EGH-8103 Electron Gun with its matching EGPS-8103 Power Supply is a complete subsystem ready to attach to the user's vacuum system and turn on. It can deliver electrons over a very broad range of energies, currents, and power. The EGH-8103 has applications in space materials testing, radiation studies, semiconductor research x-ray generation and plasma excitation.

The gun uses a refractory metal or lanthanum hexaboride (LaB_6) cathode to generate a high energy, focusable, small spot electron beam. Both beam energy and beam current are independently adjustable over wide ranges, the energy from 10 keV to 100 keV, and current from 10 nA to 1 mA. The electron beam can be pulsed by an input signal to the control grid.

The adjustable optics of the gun can adapt to different divergences and different working distances. The spot size can be varied from 500 µm to 10 mm with a refractory metal disc cathode. With a small spot option using a lanthanum hexaboride (LaB_6) cathode, the gun can deliver spots down to 60 µm. A magnetic focusing lens and magnetic centering deflection provide beam control with low aberration. In addition, the cathode to anode spacing is internally adjustable to change perveance.

EGF-8201 / EGPS-8201 System

The Kimball Physics EGH-8201 Electron Gun with its matching EGPS-8201 Power Supply is a complete subsystem ready to attach to the user's vacuum system and turn on. It can deliver electrons over a very broad range of energies, currents, and power. The EGH-8201 has high current, pulsed applications in space materials testing, radiation studies, semiconductor research x-ray generation and plasma excitation.

The gun uses a refractory metal disc cathode to generate a high energy, high current, focusable electron beam. Both beam energy and beam current are independently adjustable over wide ranges, the energy from 10 keV to 100 keV, and current from 10 nA to 1 mA and up to 20 mA pulsed. The electron beam is pulsed by an input signal to the control grid.

The adjustable optics of the gun can adapt to different divergences and different working distances. The spot size can be varied from 1 mm to 100 mm. A magnetic focusing lens and magnetic centering deflection provide beam control with low aberration. In addition, the cathode to anode spacing is internally adjustable to change perveance.

EGF-8202 / EGPS-8202 System

No longer available. Please now refer to Electron Gun System EGF-8201 / EGPS-8201 for similar specifications.

The Kimball Physics EGH-8202 Electron Gun, with its matching EGPS-8202 Power Supply is a complete subsystem ready to attach to the user's vacuum system and turn on. It can deliver electrons over a very broad range of energies, currents, and power. The EGH-8202 can be used in a variety of high power, pulsed applications in vacuum physics, such as plasma generation.

The gun uses an yttria-coated iridium cathode to generate a high energy, focusable electron beam. Both beam energy and beam current are independently adjustable over wide ranges, the energy from 10 keV to 100 keV, and current from 10 nA to 20 mA. The electron beam can be pulsed by an input signal to the control grid.

The adjustable optics of the gun can adapt to different divergences and different working distances. The spot size can be varied from 1 mm to 15 mm at the end of the gun. The working distance ranges from 0 mm (the end of the gun) to 1000 mm. Two magnetic focusing lenses and two magnetic centering deflection coils provide beam control with low aberration. In addition, the tetrode to second anode spacing is internally adjustable to change perveance.

Electron Gun Systems- High Energy (up to 100 keV)

Electron Gun System	Range	Beam Energy	Beam Current	Spot Size	Working Distance	Beam Uniformity
EGH-6210 EGPS-6210	Min	1 keV	10 µA	50 µm	50 mm	Gaussian
	Max	60 keV	5 mA	10 mm	1000 mm	
EGH-6002 EGPS-6002	Min	1 keV	10 nA	0.5 mm	50 mm	Gaussian
	Max	50 keV	100 uA	100 mm	1000 mm	
High Current	Min		10 nA			
	Max		10 mA			
Low Current	Min		100 pA			
	Max		100 nA			
EGF-6104 EGPS-6104	Min	1 keV	10 nA	15 mm	100 mm	Variable
	Max	50 keV	200 µA	50 mm	1000 mm	
High Current	Min		10 nA	15 mm		
	Max		5 mA	50 mm		
EGF-6115 EGPS-6115	Min	1 keV	10 nA	10 mm	100 mm	Nearly Uniform
	Max	50 keV	5 mA	500 mm	1000 mm	
Low Current	Min		100 pA	10 mm		
Please See EGF-6104	Max		100 nA	500 mm		
EGH-8100 EGPS-8100	Min	1 keV	10 nA	3 mm	50 mm	Gaussian
	Max	100 keV	100 µA	100 mm	1000 mm	
High Current	Min		10 nA			
	Max		1 mA (20 mA)			
EGH-8105 EGPS-8105	Min	1 keV	50 nA	15 mm	Variable	Gaussian
	Max	100 keV	100 µA	450 +		
EGH-8103 EGPS-8103	Min	10 keV	10 nA	500 µm	50 mm	Gaussian
	Max	100 keV	1 mA	10 mm	1000 mm	
Small Spot	Min		10 nA	60 µm		
	Max		100 µA	10 mm		
EGH-8201 EGPS-8201	Min	10 keV	10 nA	1 mm	50 mm	Gaussian
	Max	100 keV	1 mA	100 mm	1000 mm	
EGH-8202 EGPS-8202	Min	10 keV	10 nA	1 mm	0 mm	Gaussian
Please See EGH-8201	Max	100 keV	1 mA	100 mm	1000 mm	

Electron Source System Features (High Energy- up to 100 keV)

Electron Gun System		Applications	Features
EGH-6210 **EGPS-6210**		• General Vacuum Physics • Radiation Studies • Surface Bombardment • Semiconductor Research • Biological Specimen Radiation • X-ray Generation • Plasma Excitation • Fluorescence Studies • Surface Physics Studies	**1 keV to 60 keV** • Small Spot Size down to 50 µm • Medium Current Beams to 5 mA • High Current Beams to 10 mA • Magnetostatic Focusing • Magnetostatic Beam Shaping (optional) • Magnetostatic Deflection • Pulse Capability • Internal Alignment while operation • User-Replaceable Firing Units
EGH-6002 **EGPS-6002**		• General Vacuum Physics • Radiation Studies • Surface Bombardment • Semiconductor Research • Biological Specimen Irradiation • X-ray Generation • Plasma Excitation • Fluorescence Studies • Surface Physics Studies	**1 keV to 50 keV** • Medium Beam Currents • Focusable Small Spot Sizes- Magnetostatic Focusing • Magnetostatic Deflection • Pulse Capability • Internal Alignment while Operating • User-Replaceable Firing Units • 4.5” or 6” in CFF Mounting • UHV Technology / Bakeable • Computer / Remote Control
EGF-6104 **EGPS-6104**		• Spacecraft Charge-up Studies • Surface Charging Studies • Beta Decay Simulation • Surface Physics Studies • Vacuum Physics Experiments	**1 keV to 50 keV** • Uniform Density Flood Beam • Energy Range: 1 keV to 50 keV • Beam Currents to 200 µA • High Current Option up to 5 mA • Wide Angle Uniform Beam • Divergence Control • Rotatable 2¾ inch CFF Mounting • Flange Multiplexer Flexibility • User-replaceable Firing Units • Computer / Remote Control
EGF-6115 EGPS-6115 **Please See EGF-6104**		• General Vacuum Physics • Spacecraft Materials Testing • UHV Charging • Surface Physics	**1 keV to 50 keV** • Uniform Flood Beam • Rastering / Beam Washing for Wide Angle • Uniform Spot Size • Electrostatic Divergence Control • Magnetostatic Deflection • Internal Alignment while Operating • User-Replaceable Firing Units • 2.75” in CF Mounting • UHV Technology / Bakeable • Computer / Remote Control • LabVIEW™ Computer / Programming

Electron Source System Features (High Energy- up to 100 keV), continued

EGH-8100 **EGPS-8100**		• General Vacuum Studies • Radiation Studies • Surface Bombardment • Semiconductor Research • Biological Specimen Irradiation • X-ray Generation • Plasma Excitation • Fluorescence Studies • Surface Physics Studies	**1 keV to 50 keV** • Beam Currents up to 1 mA (20 mA pulsed) • Flood Electron Beam • Pulse Capability • Internal Alignment while Operating • User-Replaceable Firing Units • Computer Control Available
EGH-8105 **EGPS-8105**		• General Vacuum Physics • Spacecraft Materials Testing • UHV Charging • Surface Physics	**1 keV to 100 keV** • Uniform Flood Beam • Beam Washing for Uniform Spot Size • Electrostatic Focusing • Instrumentation Ports (2 x 1.33”) • Internal Alignment while operating • User-Replaceable Firing Units • 6” CFF Mounting • UHV Technology and Bakeable • Computer / Remote Control • LabVIEW™ Computer / Programming
EGH-8103 **EGPS-8103**		• General Vacuum Physics • Radiation Studies • Surface Bombardment • Semiconductor Research • Biological Specimen Irradiation • X-ray Generation • Plasma Excitation • Fluorescence Studies • Surface Physics Studies	**1 keV to 100 keV** • Small Spot Size down to 60 µm • Beam Currents up to 1 mA • Magnetostatic Focusing • Magnetostatic Deflection • Pulse Capability • Internal Alignment while operating • User-replaceable Firing Units • Computer / Remote Control
EGH-8201 **EGPS-8201**		• General Vacuum Physics • Radiation Studies • Surface Bombardment • Semiconductor Research • Biological Specimen Irradiation • X-ray Generation • Plasma Excitation • Fluorescence Studies • Surface Physics Studies	**1 keV to 100 keV** • High Beam Currents, to 20 mA Pulsed • Focusable • Spot Size down to 1 mm • Magnetostatic Focusing • Magnetostatic Deflection (Optional) • Pulse Capability • Internal Alignment while Operating • Computer / Remote Control • User-replaceable Firing Units

Electron Source System Features (High Energy- up to 100 keV), continued

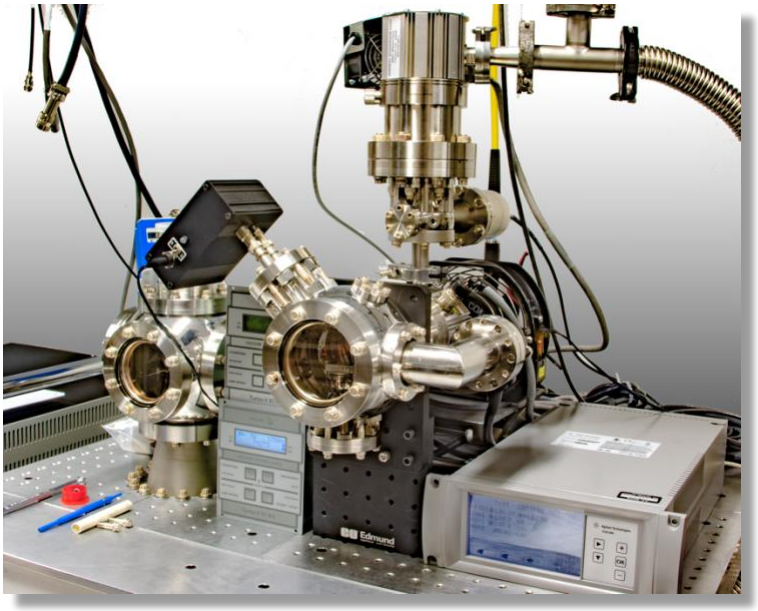
EGH-8202 EGPS-8202 **Please see EGH-8201**		• Vacuum Physics Experiments • Plasma Excitation	**10 keV to 100 keV** • High Beam Currents up to 20 mA Pulsed • Magnetostatic Focusing- Two Lens System • Magnetostatic Deflection • Pulse Capability • Differential Pumping and Optional Gate Valve • User-Replaceable Firing Units

Quality Control and Precision Assembly

All electron gun systems are tested In-vacuum for specification acceptance. A detailed manual, specific to the individual system with its options, is provided with all electron and ion gun systems.

Custom Applications

Many of the electron gun systems provided by Kimball Physics have been innovated, designed, and manufactured for the customized specifications of our customers. If you do not see the configuration and parameters in an electron gun system that you need, please reach out to Kimball Physics to engage our physicists, engineers, and fabrication specialists. Also, please inquire about options for OEM applications.



A typical laboratory setup of a Kimball Physics Electron Gun System. Main power supply only partially in view.

References

General Information	For more information on Electron Gun and Power Supply Systems, please visit the Resource Section of the Kimball Physics Website. „

Electron Gun Systems	Document Name
Low Energy	
FRA-2X1-2 EGPS-1011	FRA-2X1-2 / EGPS-1011
ELG-2 EGPS-1022	ELG-2 / EGPS-1022
EGA-1012 EGPS-1012	EGA-1012 / EGPS-1012
EFG-7 EGPS-1017	EFG-7 / EGPS-1017
EFG-7 EGPS_2017	EFG-7 / EGPS_2017
EGL-2022 EGPS_2022	EGL-2022 / EGPS_2022
Medium Energy	
EGG-3101 EGPS-3101	EGG-3101 / EGPS-3101
EGG-3103 EGG-3103	EGG-3103 / EGG-3103
EGF-3104 EGPS-3104	EGF-3104 / EGPS-3104
EMG-4212 EGPS-3212	EMG-4212 / EGPS-3212
EMG-4212 EGPS-4212	EMG-4212 / EGPS-4212
EMG-4215 EGPS-4215	EMG-4215 / EGPS-4215
EGF-4104 EGPS-4104	EGF-4104 / EGPS-4104
EMG-4210 EGPS-4210	EMG-4210 / EGPS-4210
EMG-4193 EGPS-4190 COPS-4190	EMG-4193 / EGPS-4190 / COPS-4190
High Energy	
EGH-6210 EGPS-6210	EGH-6210 / EGPS-6210
EGH-6002 EGPS-6002	EGH-6002 / EGPS-6002
EGF-6104 EGPS-6104	EGF-6104 / EGPS-6104
EGF-6115 EGPS-6115	EGF-6115 / EGPS-6115 Please see EGF-6104 for similar specifications.
EGH-8100 EGPS-8100	EGH-8100 / EGPS-8100
EGH-8105 EGPS_8105	EGH-8105 / EGPS_8105
EGH-8103 EGPS-8103	EGH-8103 / EGPS-8103
EGH-8201 EGPS-8201	EGH-8201 / EGPS-8201
EGH-8202 EGPS-8202	EGH-8202 / EGPS-8202 Please see EGH-8201 for similar specifications.

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, D Taylor 3/4/2024

Document: KP_Electron_Gun_Systems_Summary_2024_0304