

High Luminosity Phosphor Screens: Rugged and UHV Compositions with Standard (eV Part®) Plate and Thin Flange Mounting

APPLICATIONS:

- Beam Detection
- Beam Alignment
- Lens Testing
- Uniformity Testing
- Surface Physics
- **RHEED** (Reflection High-Energy Electron Diffraction) techniques for surface characterization
- UHV Experiments

FEATURES / OPTIONS:

- Phosphor Screens Using High Luminosity P22 Blue Phosphor
- Sensitive to Electrons Starting at 500 eV
- Rugged and UHV Screens
- Metal and Glass Backings
- Thin Flange Mounting Option (2.75", 4.50" and 6.00" CF) to Mount between existing Viewport and CF flange with 1.43", 2.83" and 4.20" diameter screens respectively
- Standard Sizes Mounted with Kimball Physics eV Parts®, with Screen Sizes of 0.50", 0.75", 1.00", 1.50"



Phosphor Screens in various sizes and configurations: Thin Flange Mounted Phosphor Screen (left) and Standard eV Part® Mounted Phosphor Screens (right).

Phosphor Screens: Rugged and UHV

Kimball Physics Phosphor Screens are made of a high luminosity phosphor (Blue P22- ZnS: Ag). Interestingly, phosphor does not contain phosphorus.

The screens are sensitive to electrons and will emit photons (luminescence) starting at approximately 500 eV with a threshold of 1×10^{-7} A/cm² at 500 eV. The maximum recommended input beam power density is 1 Watt/cm². Two general types of phosphor

screens are made by Kimball Physics: Rugged Phosphor Screens and UHV Phosphor Screens.

Rugged Phosphor Screens

Rugged Phosphor Screens (Kimball Physics **PHOS-RP22**) are easy to handle and unusually resistant to mechanical damage and rough handling. In these ruggedized screens, phosphor is bonded to either metal or glass backings using a bonding agent which has a low but *non-zero* vapor pressure. Due to the binder, the rugged phosphor is only suitable for vacuum

Phosphor Specifications

Phosphor Type	ZnS:Ag Type 1330 (P-22 Blue)
Saturation Threshold	3×10^{-2} Amps/cm ²
Peak Emitted Wavelength	450 nanometers
Maximum Input Power Density	1 Watt/cm ²
Minimum Power Density	5×10^{-5} Watts/cm ²

pressures down to 10^{-8} torr (at the lower end of this operating range, some outgassing may be observed). The rugged screens are particularly suited for use in experimental vacuum systems. Rugged screens have a phosphor thickness of approximately 75 μm . They are fabricated from high luminosity blue phosphor (P-22), available with either stainless steel 304 or glass backings. They are bakeable to 200°C. The phosphor screens are available in two basic configurations: 1) Phosphor Screen diameters of 0.50", 0.75", 1.00" and 1.50" mounted on Square eV Part Plates with Round Center holes or 2) Phosphor Screen diameters of 1.43", 2.83" and 4.20" that are secured in the apertures of Thin Flange Mounts (2.75", 4.50", 6.00" CF respectively). *We also refer to our CF Flange Mounted Phosphor Screens as RHEED Screens.*

UHV Phosphor Screens

UHV Phosphor Screens (Kimball Physics **PHOS-UP22**), with no binder, are compatible with ultra-high vacuums (UHV) better than 1×10^{-8} torr. Although these screens do well in an UHV environment, they are more fragile and require greater care when handling. Since the phosphor coating is delicate, it can be easily damaged from touching the UHV phosphor coating. Also, shock from knocking or dropping the screen may cause the phosphor coating to flake off. Standard UHV screens are shipped with a stainless-steel protective cover. The thickness of the UHV phosphor ranges from 50 μm to 70 μm .

The UHV screens are fabricated from high luminosity blue phosphor (P-22). They are bakeable to 350°C and are available in phosphor screen diameters of 0.50", 0.75", 1.00" and 1.50" for eV Part Plate Mounts and 1.43", 2.83" and 4.20" for Thin Flange Mounts (2.75", 4.50", 6.00" CF respectively).

Metal and Glass Phosphor Backing

During fabrication of the Phosphor Screens, the phosphor can be deposited either on a 0.012 or 0.025 inch thick 304 stainless steel plate (SS) or on 0.030-inch-thick conductive glass (GL).

Phosphor Screen Configurations

The screens can be configured as: 1) square or custom shaped stainless steel plates (with

Phosphor Screen Notes:

- 1) Using the phosphor screens at electron energies below the first unity-secondary-emission crossover point may cause the screen to charge up to electron cathode potential, at which point the screen temporarily goes out.
- 2) When using the phosphor screen, input power density should not exceed 1 Watt/cm², or the phosphor coating may be damaged. To preserve screen brightness, it is advisable to use the lowest beam power density that provides a clear spot. Normal usage will result in gradual browning of the screen.
- 3) Ruggedized screens are bakeable up to 200°C; UHV screens are bakeable up to 350°C.
- 4) Larger screens, mounted in either six- or eight-inch viewports are also available as an option. The diameter of a screen for a six-inch viewport would be 4.2 inch and the diameter of a screen for a eight inch viewport would be 6.2 inch. These larger phosphor screens can be deposited on leaded glass if required.
- 5) Rugged screens on stainless steel can be deposited, as an option, directly on the eV square plate.
- 6) UHV screens on stainless steel is deposited on a round stainless steel plate that is affixed to the square mounting plate by four equally spaced tabs spot-welded to the square mounting plate and to the underside of the round (phosphor- coated) plate.
- 7) Standard phosphor screens deposited on conductive glass (both Rugged and UHV) are held between two stainless steel plates, within a center hole, by four equally spaced tabs on both sides of the screen. The tabs, which are spot-welded to the stainless steel plates, also serve to bleed off charge from the screens.



Examples of various sized Standard Phosphor Screens (0.7", 1.4" and 2.0" Edge length) with conductive glass (0.5", 1.0", 1.5" diameter) screens mounted in the central aperture of two adjacent square eV Part® plates. Tabs present to secure screens and conduct away charge.

deposition directly on the plate- these are available custom), 2) phosphor deposited on round SS or glass disk, with the phosphor screen disk held in place with between two adjacent Kimball Physics eV Part Square Plates with round center holes, or 3) the phosphor screen is supported within the round aperture of a CF Thin Flange fitting that is discussed below.

The screens with phosphor deposited on metal surface must be viewed from the electron impact side (since the metal is opaque) with their frames typically mounted in vacuum at an angle and in view behind the viewport.

The phosphor screens deposited on glass can be viewed from either side (since the glass is transparent). These screens can be either be: 1) mounted on a square stainless steel (eV Part compatible) perforated plates with a round central aperture or 2) mounted in a Thin Flange fixture. The Thin Flange fixture with the phosphor screen is then mounted (sandwiched) between two CF flanges, such as the vacuum chamber port flange and a viewport flange.

Custom Phosphor Screens can be deposited on almost any metal, glass, or ceramic surface on a special-order basis. Round screen diameters can range from 10 mm diameters, up to more than 200 mm in diameter. Rugged phosphor screens can be made in a variety of custom sizes and shapes; rectangles, strips, and patterned shapes are possible; edge definition is better than 100 micrometers. Custom screens can be made up even in quantities of one. Contact Kimball Physics Engineering for more information.

Standard Plate Mounted Screens

Rugged and UHV screens typically deposited on various sized round stainless steel disks or round disks of conductive glass and then mounted in the center round hole of a square stainless steel eV Part plates using tabs to secure the disk and also conduct away charge from the screen (see figure previous page)

The Rugged phosphor screens can also be deposited directly on an eV Plate (custom, see figure right).

Thin Flange Mounted Phosphor Screens

The Thin Flange-Mounted Phosphor Screen, that we commonly refer to as RHEED Phosphor Screens because they are frequently used for Reflection High Energy Electron Diffraction techniques for surface characterization, is designed for in-vacuum mounting (see figure below). It is typically used in conjunction with a separate ConFlat® CF viewport flange. The Thin Flange is used to mount (sandwich) the phosphor screen between a separate CF Viewport and the CF flange on the vacuum chamber port. The Thin Flange has CF knife-edges on both sides that engage to copper gasket (or similar) to create the seal when the bolts are tightened. The gasket crushing bolts pass through the Thin Flange without putting any force on it.

The Thin Flange-Mounted Phosphor Screens come in 2.75" CF, 4.50" CF and 6.00" CF flange sizes. Screens for 8.00" CF are available as a special option. All Thin Flanges are 0.4 inch thick, double-sided (knife-edges on both sides), and have double-density clear bolt holes. Please refer to the "Thin Flange" specifications in the



Thin Flange 6.00" CF with conductive glass backed phosphor screen mounted in the flange aperture. Small tabs secure the screen and conduct charge from the screen to the flange and then to ground.



Maltese-cross shaped spot from an unfocused LaB₆ cathode seen on a custom phosphor screen inside the vacuum chamber.

Examples of Phosphor Screens Mounted on Various eV Part® Plates

PHOS-RP22SS-B5x5-R500 (Rugged)

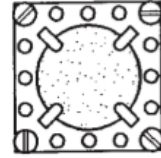
PHOS-UP22SS-B5x5-R500 (UHV)

0.50 inch phosphor on 0.700 inch square,
0.012 inch thick stainless steel B5x5 plate

PHOS-RP22GL-B5x5-R500 (Rugged)

PHOS-UP22GL-B5x5-R500 (UHV)

0.50 inch phosphor on 0.030 inch thick
conductive glass fitting in a 0.700 inch square,
0.012 inch thick stainless steel B5x5 plate



PHOS-RP22GL-B5x5-R500

PHOS-RP22SS-B7x7-R750 (Rugged)

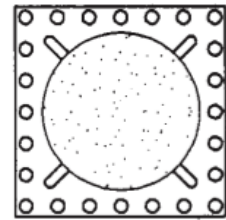
PHOS-UP22SS-B7x7-R750 (UHV)

0.75 inch phosphor on 1.000 inch square,
0.012 inch thick stainless steel B7x7 plate

PHOS-RP22GL-B7x7-R750 (Rugged)

PHOS-UP22GL-B7x7-R750 (UHV)

0.75 inch phosphor on 0.030 inch thick
conductive glass fitting in a 1.000 inch square,
0.012 inch thick stainless steel B7x7 plate



PHOS-UP22SS-B7x7-R750

PHOS-RP22SS-C5x5-R1000 (Rugged)

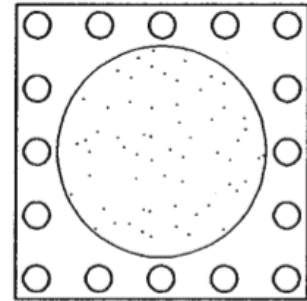
PHOS-UP22SS-C5x5-R1000 (UHV)

1.00 inch phosphor on 1.400 inch square,
0.025 inch thick stainless steel C5x5 plate

PHOS-RP22GL-C5x5-R1000 (Rugged)

PHOS-UP22GL-C5x5-R1000 (UHV)

1.00 inch phosphor on 0.030 inch thick
conductive glass fitting in a 1.400 inch square,
0.025 inch thick stainless steel C5x5 plate



PHOS-RP22SS-C5x5-R1000

PHOS-RP22SS-C7x7-R1500 (Rugged)

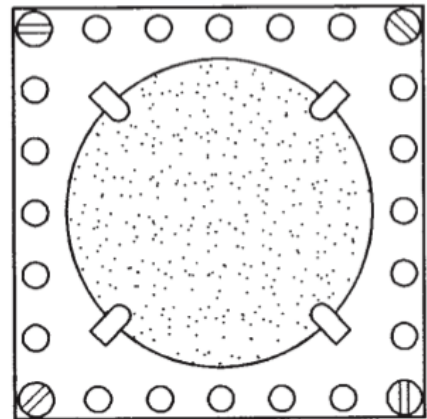
PHOS-UP22SS-C7x7-R1500 (UHV)

1.50 inch phosphor on 2.000 inch square,
0.025 inch thick stainless steel C7x7 plate

PHOS-RP22GL-C7x7-R1500 (Rugged)

PHOS-UP22GL-C7x7-R1500 (UHV)

1.50 inch phosphor on 0.030 inch thick
conductive glass fitting in a 2.000 inch square,
0.025 inch thick stainless steel C7x7 plate



PHOS-UP22GL-C7x7-R1500

Rugged Phosphor Screens

- High luminosity Phosphor (P-22 Blue)
- Ruggedized, resists damage
- Vacuum only to 10^{-8} torr, possible outgassing
- Input $1\text{W}/\text{cm}^2$ max
- Bakeable to 200°C
- SS304 or glass backing
- Standard sizes up to 1.5" screen diameter



Rugged Phosphor Screen	Phosphor Size (Ø)	Phosphor Backing	eV Plate Mount	Notes eV Plate Mount
PHOS_RP22SS-B5X5-R500	0.50"	SS	B5X5-R500	5 holes each side of 0.700" Square, with Centered Round Hole 0.500"
PHOS_RP22SS-B7X7-R750	0.75"	SS	B7X7-R750	7 holes each side of a 1.000" Square plate, with Centered Round Hole 0.750"
PHOS_RP22SS-C5X5-R1000	1.00"	SS	C5X5-R1000	5 Holes each side of 1.400" Square plate, with Centered Round Hole 1.000"
PHOS_RP22SS-C5X5-R1500	1.50"	SS	C7X7-R1500	7 Holes each side of 2.000" Square plate, with Centered Round Hole 1.500"
PHOS-RP22GL-B5X5-R500	0.50"	Glass	B5X5-R500	5 holes each side of 0.700" Square, with Centered Round Hole 0.500"
PHOS-RP22GL-B7X7-R750	0.75"	Glass	B7X7-R750	7 holes each side of a 1.000" Square plate, with Centered Round Hole 0.750"
PHOS-RP22GL-C5C5-R1000	1.00"	Glass	C5X5-R1000	5 Holes each side of 1.400" Square plate, with Centered Round Hole 1.000"
PHOS-RP22GL- C7C7-R1500	1.50"	Glass	C7X7-R1500	7 Holes each side of 2.000" Square plate, with Centered Round Hole 1.500"
Notes: Plate Thickness: B plates 0.012", C Plates 0.025" B Plates Holes: Hole Size 0.062", Hole spacing 0.150" C Plates Holes: Hole Size 0.125", Hole Spacing 0.300" B Plate Size: Square 5 Hole (B5x5) 0.700" x 0.700",			Square 7 Hole (B7x7) 1.000" x 1.000" C Plate Size: Square 5 Hole (C5x5) 1.400" x 1.400", Square 7 Hole (C7x7) 2.000" x 2.000", Rectangular 3 x 5 Hole (C3x5) 0.750" x 1.400" RP = Rugged Phosphor Screen SS = Stainless Steel Backing GL = Conductive Glass Backing	

Rugged Phosphor Specifications	
Phosphor Type	ZnS: Ag Type 1330 (P-22 Blue)
Phosphor Screen Type	Rugged
Phosphor Screen Backing	Stainless Steel
Saturation Threshold	3×10^{-2} Amps/cm ²
Peak Emitted Wavelength	450 nanometers
Maximum Input Power Density	1 Watt/cm ²
Minimum Power Density for Screen Response	5×10^{-5} Watts/cm ²
Max. Bakeout Temperature	200°C
Notes:	
•Rugged; vacuum only to 10^{-8} torr, possible outgassing at lower end of vacuum range	

UHV Screens

- High luminosity Phosphor (P-22 blue)
- Vacuum better than 10^{-8} torr
- Delicate coating
- Input $1\text{W}/\text{cm}^2$ max
- Bakeable to 350°C
- SS304 or glass backing
- Standard sizes up to 1.5" screen diameter



UHV Phosphor Screen	Phosphor Size (Ø)	Phosphor Backing	eV Plate Mount	Notes eV Plate Mount
PHOS_UP22SS-B5X5-R500	0.50"	SS	B5X5-R500	5 holes each side of 0.700" Square, with Centered Round Hole 0.500"
PHOS_UP22GL-B5X5-R500	0.50"	Glass	B5X5-R500	5 holes each side of 0.700" Square, with Centered Round Hole 0.500"
PHOS_UP22SS-B7X7-R750	0.75"	SS	B7X7-R750	7 holes each side of a 1.000" Square plate, with Centered Round Hole 0.750"
PHOS_UP22GL-B7X7-R750	0.75"	Glass	B7X7-R750	7 holes each side of a 1.000" Square plate, with Centered Round Hole 0.750"
PHOS_UP22SS-C5X5-R1000	1.00"	SS	C5X5-R1000	5 Holes each side of 1.400" Square plate, with Centered Round Hole 1.000"
PHOS_UP22GL-C5X5-R1000	1.00"	Glass	C5X5-R1000	5 Holes each side of 1.400" Square plate, with Centered Round Hole 1.000"
PHOS_UP22SS-C5X5-R1500	1.50"	SS	C7X7-R1500	7 Holes each side of 2.000" Square plate, with Centered Round Hole 1.500"
PHOS_UP22GL-C5X5-R1500	1.50"	Glass	C7X7-R1500	7 Holes each side of 2.000" Square plate, with Centered Round Hole 1.500"
Notes:		C Plate Size:		
Plate Thickness:		Square 5 Hole (C5x5) 1.400" x 1.400",		
B plates 0.012",		Square 7 Hole (C7x7) 2.000" x 2.000",		
C Plates 0.025"		Rectangular 3 x 5 Hole (C3x5) 0.750" x 1.400"		
B Plates Holes: Hole Size 0.062", Hole spacing 0.150"		UP = UHV Phosphor Screen		
C Plates Holes: Hole Size 0.125", Hole Spacing 0.300"		RP = Rugged Phosphor Screen		
B Plate Size:		SS= Stainless Steel Backing		
Square 5 Hole (B5x5) 0.700" x 0.700",		GL= Glass Backing		
Square 7 Hole (B7x7) 1.000" x 1.000"				

UHV Phosphor Specifications	
Phosphor Type	ZnS: Ag Type 1330 (P-22 Blue)
Phosphor Screen Type	UHV
Phosphor Screen Backing	Stainless Steel 304, Conductive Glass
Saturation Threshold	3×10^{-2} Amps/cm ²
Peak Emitted Wavelength	450 nanometers
Maximum Input Power Density	1 Watt/cm ²
Minimum Power Density for Screen Response	5×10^{-5} Watts/cm ²
Max. Bakeout Temperature	350°C
Notes:	
•Operating Vacuum Range; UHV Range, compatible with better than 10^{-8} torr	

RHEED Phosphor Screen

- Phosphor Screens on Glass mounted in 2.75" CF, 4.50" CF, and 6" CF Thin Flanges.
- The Thin Flange Phosphor Screen must be inserted between two CF flanges, such as a Viewport and a vacuum chamber CF port
- The phosphor screen is typically mounted just behind the vacuum chamber viewport.
- Custom sizes and shapes available



RHEED Phosphor Screen	Phosphor Screen Size	Phosphor Type	Mount	Notes Thin Flange Mount
PHOS-RP22GL-CF2.75 P22	1.43"	Rugged	Thin Flange	2.75" CF Thin Flange Mount
PHOS-UP22GL-CF2.75 P22	1.43"	UHV	Thin Flange	2.75" CF Thin Flange Mount
PHOS-RP22GL-CF4.50 P22	2.83"	Rugged	Thin Flange	4.50" CF Thin Flange Mount
PHOS-UP22GL-CF4.50 P22	2.83"	UHV	Thin Flange	4.50" CF Thin Flange Mount
PHOS-RP22GL-CF6.00 P22	4.20"	Rugged	Thin Flange	6.00" CF Thin Flange Mount
PHOS-UP22GL-CF6.00 P22	4.20"	UHV	Thin Flange	6.00" CF Thin Flange Mount
Available as an option	6.20"		Thin Flange	8.00" CF Thin Flange Mount

Notes:

- Phosphor Screens are all mounted on Glass
- 0.4" thick double-sided Multi-CF Thin Flanges
- Thin Flange typically sandwiched between a Viewport Flange and the corresponding system flange
- CF Flange Sizes
 - 2.75" CF Thin Flange Mount: MCF275-ThnFlg-C2-400-ID1500GG
 - 4.50" CF Thin Flange Mount: MCF450-ThnFlg-E2-400-ID2900GG
 - 6.00" CF Thin Flange Mount: MCF600-ThnFlg-F2-400-ID4300GG
 - 8.00" CF Thin Flange Mount: MCF800-ThnFlg-G2-400-ID6300GG

RHEED Phosphor Specifications	
Phosphor Type	ZnS: Ag Type 1330 (P-22 Blue)
Phosphor Screen Type	Rugged, UHV
Phosphor Screen Backing	Conductive Glass
Saturation Threshold	3×10^{-2} Amps/cm ²
Peak Emitted Wavelength	450 nanometers
Maximum Input Power Density	1 Watt/cm ²
Minimum Power Density for Screen Response	5×10^{-5} Watts/cm ²
Max. Bakeout Temperature	Rugged 200°C, UHV 350°C
Notes:	
• Rugged Operating Vacuum Range: vacuum only to 10^{-8} torr, possible outgassing at higher vacuum (smaller pressure range)	
• UHV Operating Vacuum Range: UHV Range, compatible with better than 10^{-8} torr	

Care and Handling Rugged, UHV and RHEED Phosphor Screens

Cautions	•Rugged •Rugged RHEED	Handle with care. Although the phosphor is bonded to SS or glass to resist mechanical shock or accidental touching of the screen, handle the ruggedized screen with reasonable care and do not scrape the phosphor.
	•UHV •UHV RHEED	Handle with care. Use caution when handling the phosphor screen as the coating is extremely delicate. Do not touch the Phosphor Coating or damage may result. Banging or knocking the screen or its mount on a hard surface could cause phosphor to flake off.
Shipping Protection	•RHEED	For protection of the RHEED Phosphor Screen, it is shipped with a Plexiglass cover and a steel base. The cover should be removed by a qualified technician wearing clean room gloves. Do not touch or knock the phosphor surface while removing the cover. • Remove the 12-point bolts • Carefully lift off the Plexiglas cover; it will expose the fragile phosphor surface • Holding the edge of the flange, remove phosphor screen with its flange from the steel base. Save the cover and base for shipping or storage.
Grounding	•All phosphor screens	After installation, ensure that the screen is properly grounded.
Maximum Input Power Density	•Rugged •UHV •RHEED	1 Watt/cm ² Caution: Exceeding 1 Watt/cm ² input power may damage the phosphor coating. To preserve screen brightness, it is advisable to use the lowest power density that provides a clear spot. Input Power Density = $\frac{\text{Beam Current} \times \text{Beam Energy}}{\text{Spot Size (area)}}$

References

For more information about Kimball Physics Detectors, please visit our website:
Kimball Physics Detectors

Other References

Thin Mounting Flanges
eV Parts

Notes:

1. Cautions when directly attaching to MCF Chambers:

- Silver Plated Bolts or Equivalent Lubrication must be used
- Please measure the hole depth and other flange / copper ring /part thicknesses
- Choose a correct bolt length such that the bolt doesn't bottom in the tapped hole prior to tightening the structure.

2. Specifications Subject to Change Without Notice.

3. DE Altobelli, DT Taylor 1/17/2024

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