SONY

VPL-VW5000ES

Technical Background

4K HDR Z-Phosphor LASER LIGHT SOURCE SXRD

Welcome

Home theater is undergoing a transformation as dramatic as the change from standard definition to high definition nearly 20 years ago. And Sony's VPL-VW5000ES is uniquely qualified to bring out the best in this new era.

The projector is distinguished by a suite of six key technologies:

- Sony's proprietary SXRD® microdisplays
- True 4K resolution (native 4096 x 2160 microdisplays)
- 3-chip color
- High Dynamic Range and associated advances
    - BT.2020 wide color gamut emulation
    - 10-bit encoding
    - High Frame Rates
- Z-Phosphor™ laser light source
- 5,000 lumens brightness

While we list them as separate items, these technologies work together to form one fundamental advancement. The SXRD microdisplays enable true 4K resolution. The laser light source makes possible 5,000 lumens. HDR and 4K work hand-in-hand: the first offers a wider range of brightness levels while the second provides more pixels across which to paint those levels, so tonal gradations appear more lifelike. And 5,000 lumens maximizes the impact of HDR. You get the on-screen brightness to reproduce emissive sources (like the sun) and bright reflections in the most natural way.

As a result of these key technologies, the projector delivers a more "organic" picture, with brightness, resolution, dynamic range and color merging to form a seamless whole. Viewing is more immersive, more emotionally compelling and closer to the experience of actually being there than ever before

For all these reasons, the VPL-VW5000ES is ready to perform as the centerpiece in the most advanced home theaters, today and for years to come.

Sony's Heritage

Sony's leadership in home theater technology is not recent. Nor is it an accident. It's the natural consequence of decades spent advancing technology in projection, high-end displays and broadcast and cinema production.

1973		**VPP-2100** Sony's first color video projection system
1982		**VPH-1020Q** "Universal" PAL/NTSC/RGB projector
1989		**HDIH-2000** Sony's first commercial high definition projector
1993		**LPH-350J and VPL-350Q** Sony's first 3LCD projectors
2003		**QUALIA™ 004** World's first microdisplay Full HD projector and the first with Sony's SXRD® panels
2005		**SRX-R110 and R105** World's first commercial projectors with 4K (4096 x 2160) resolution
2006		**SRX-R220** World's first 4K projector purpose built for Digital Cinema
2011		**VPL-VW1000ES** World's first 4K home theater projector
2012		**F65** Digital motion picture camera with 20 million pixel 8K sensor, color gamut far beyond Rec. 709, High Dynamic Range with 14+ stops of exposure latitude and 16-bit linear RAW recording
2012		**XBR-84X900** Sony's first 4K Ultra HD television
2013		**VPL-FHZ55** World's first 3LCD laser phosphor projector and the first with Sony's Z-Phosphor™ laser light source
2015		**BVM-X300** Emmy® Award winning professional evaluation monitor with Sony's TRIMASTER EL® OLED technology providing native 4K resolution, High Dynamic Range and Wide Color Gamut
2015		**HDC-4300** Another Emmy® Award winner, the world's first camera with three 2/3-inch sensors and native 4K Ultra HD resolution; also featuring HDR, wide color gamut and high frame rates.
2015		**VPL-GTZ1** World's first 4K laser light source home theater projector, also featuring ultra-short throw design
2016		**VPL-VW5000ES** Sony's first 4K HDR home theater projector

Key technology #1:
The SXRD microdisplay

Sony's proprietary Silicon X-tal (crystal) Reflective Display (SXRD®) chip, has proven to be a foundational advance in projection technology. It has underpinned Sony's repeated breakthroughs in projector resolution for over 12 years. To appreciate Sony's SXRD microdisplays, it helps to consider the world before microdisplays, the age of Cathode Ray Tube (CRT) projection.

The limitations of CRT projection

From the dawn of home video projectors in the 1970s through the end of the last century, the dominant technology was the CRT. Projectors typically used three CRTs: one each for Red, Green and Blue. In this system, the CRTs were responsible for providing both resolution and brightness. Unfortunately, it was very difficult for a CRT to do both.

A classic from a bygone era, the Sony VPH-G90U incorporated 9-inch CRTs and achieved 2500 x 2000 resolution – but could only output 350 ANSI lumens.

To achieve higher performance, designers were forced to employ larger and larger CRTs, like the 9-inch tubes of Sony's well-loved VPH-G90U of 1999. While that projector was capable of gorgeous images and 2500 x 2000 resolution, it could only output 350 ANSI lumens. Considered paltry by today's standards, this output limited the G90U to relatively small screens or rooms with carefully controlled ambient lighting.

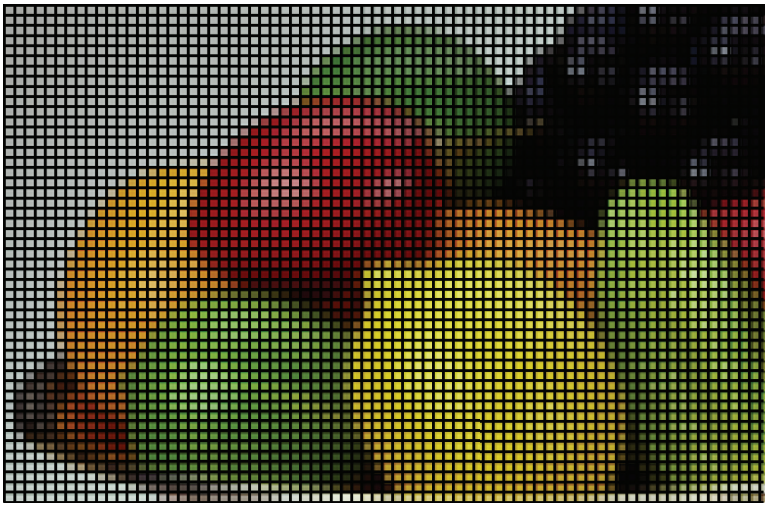
Microdisplay projection overcomes this bottleneck through division of labor. Resolution is determined only by the microdisplay; while brightness is primarily determined by an external light source.

Sony and microdisplay projection

Sony was quick to recognize the enormous potential of microdisplays. That's why we've been building microdisplay projectors since 1993. And we don't just build the projectors; we build the microdisplays inside. In fact, while there are dozens and dozens of projector brands, Sony is among the very few that builds microdisplays in-house. We manufacture both our SXRD and our transmissive LCD BrightEra® panels in our Kokubu and Kumamoto Technology Centers. In-house panel manufacturing has enabled Sony to innovate, decade after decade.

The issue of inter-pixel gaps

When Sony developed the SXRD panel, the dominant microdisplay technology was transmissive LCD. As the name implies, transmissive LCD requires the light to shine through. Because the pixel transistors are transparent, they don't cause a problem. Unfortunately, the addressing wires that drive and control the pixels are not transparent. They must run alongside the pixels, creating substantial "inter-pixel gaps" that block the light. These gaps were so big that they occupied as much as 50% of the screen. This left an active picture area (or "fill factor") of just 50%.

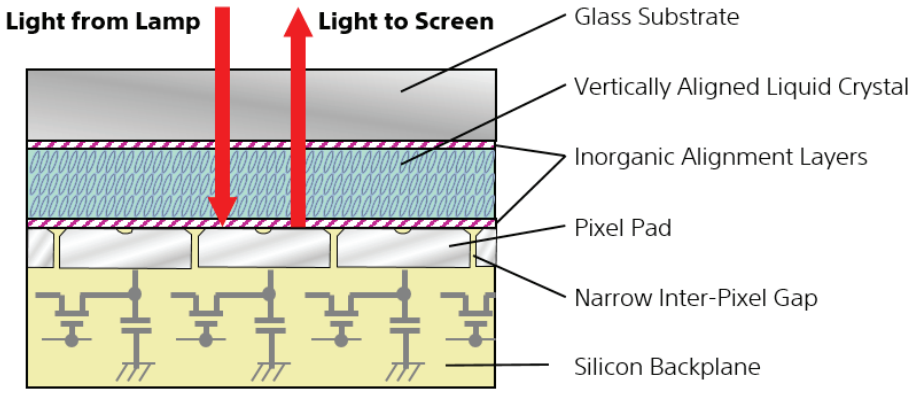


Wide inter-pixel gaps can make it seem as though you're looking at the image through a screen door. Hence the name "screen-door effect."

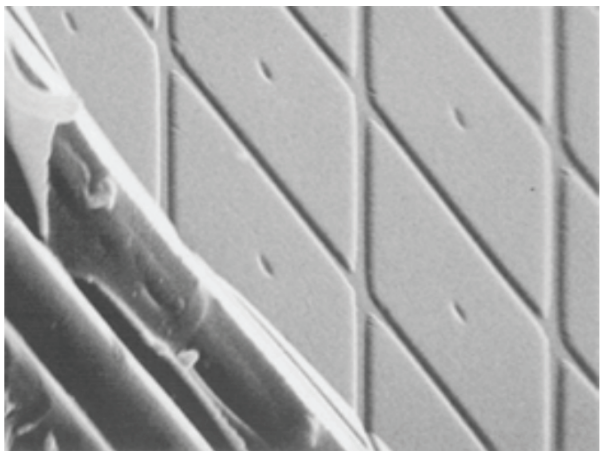
A fill factor of 50% creates issues in projector design. It lowers image brightness, because so much of the projector's lamp light is blocked. It creates "screen door effect" in the projected image, giving each pixel an individual outline. And in terms of system design, large inter-pixel gaps also require large pixels, which make high-resolution chips relatively expensive. Sony recognized that the transition to HD projection demanded a smarter approach.

The SXRD solution

Sony's answer was the SXRD chip. Instead of shining light through the chip, the light reflects off a polished aluminum surface, behind which we can hide the transistors and all the pixel address wires. The benefits are profound.

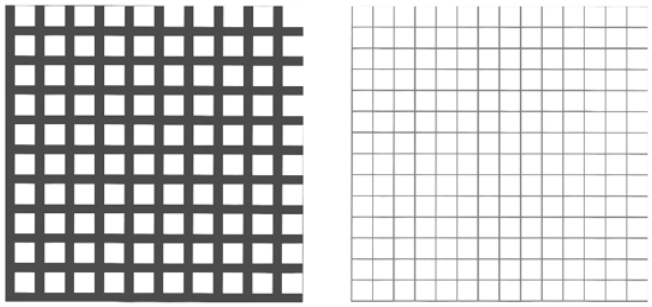


The SXRD panel in cross section. Light from the projection lamp enters through the glass substrate at the top, reflects off the mirrored surface and passes back out through the Liquid Crystal, toward the screen.



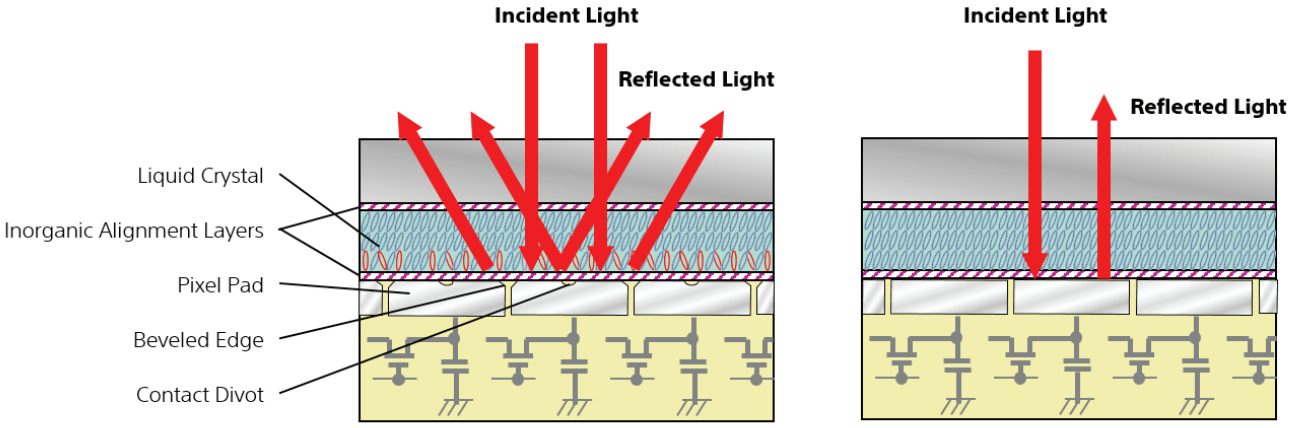
Photomicrograph of the first-generation SXRD panel. You can see that the inter- pixel gaps are quite narrow in comparison the live picture area. Each pixel has a beveled edge and a "contact divot" in the center.

- **High fill factor.** Hiding the pixel address wires enables the inter-pixel gaps to be quite small. So the proportion of the chip surface devoted to active picture area can be quite high: 92% in our first-generation chips, compared to the 50% fill factor for the transmissive LCDs of the time. This enables Sony to deliver high resolution without sacrificing brightness.



Compared to the typical transmissive LCDs of the time, Sony's first SXRD panel delivered thinner inter-pixel gaps, which translate to higher fill factor and higher pixel density. These are crucial advantages for achieving brightness and resolution.

- **Superb contrast.** From the outset, the SXRD panel achieved very high native contrast. Previous LCD projectors had used Twisted Nematic (TN) liquid crystal, which normally displays white. The SXRD panel uses a proprietary Vertically Aligned Nematic (VAN) liquid crystal, which normally displays black. The normally black state helps prevent stray light from washing out the image, improving black levels and increasing contrast. With succeeding generations of chips, Sony upgraded the chip-making process to drive contrast higher still. We refined the pixel surface, eliminating the center "contact divot" and beveled edges. We also improved the liquid crystal alignment. These upgrades dramatically reduced scattered light, optimizing black levels and maximizing contrast.



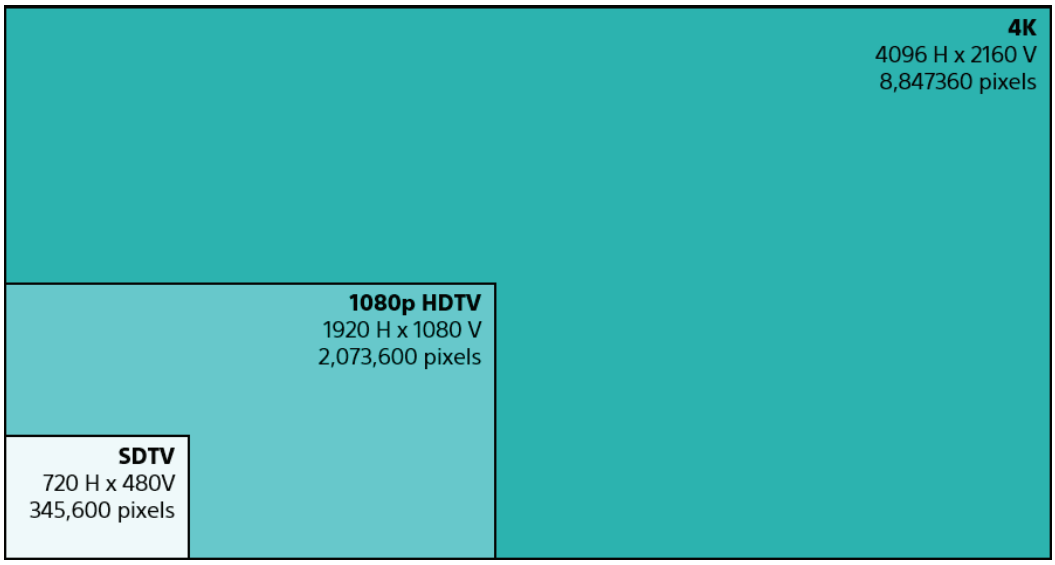
Improving liquid crystal alignment and eliminating both the contact divot and the beveled edge minimize stray reflections. The result: a substantial improvement in black levels.

- **High pixel density.** There are two ways to increase the native resolution of a microdisplay projector. You can take an existing chip technology and build larger chips. Unfortunately, large chips are expensive, and they require larger, more expensive light engines, optical blocks and lenses. That's why Sony went the other route, shrinking the pixels and increasing pixel density. Sony's first generation SXRD chip was a Full HD 0.78-inch diagonal panel that achieved an astonishing 12,400 pixels per square millimeter. These pixels were so microscopically small that it would have taken about 29,000 of them to form a rectangle to cover the "E" in the word "LIBERTY" in the US quarter dollar. In comparison, the VPL-VW5000ES incorporates slightly smaller, 0.74-inch chips with more than four times the pixels per square mm. The phenomenal pixel density of Sony's SXRD chips enabled us to create the world's first Full HD microdisplay projector, world's first commercial 4K projector and world's first 4K home theater projector. None of these achievements would have been possible without the SXRD microdisplay.

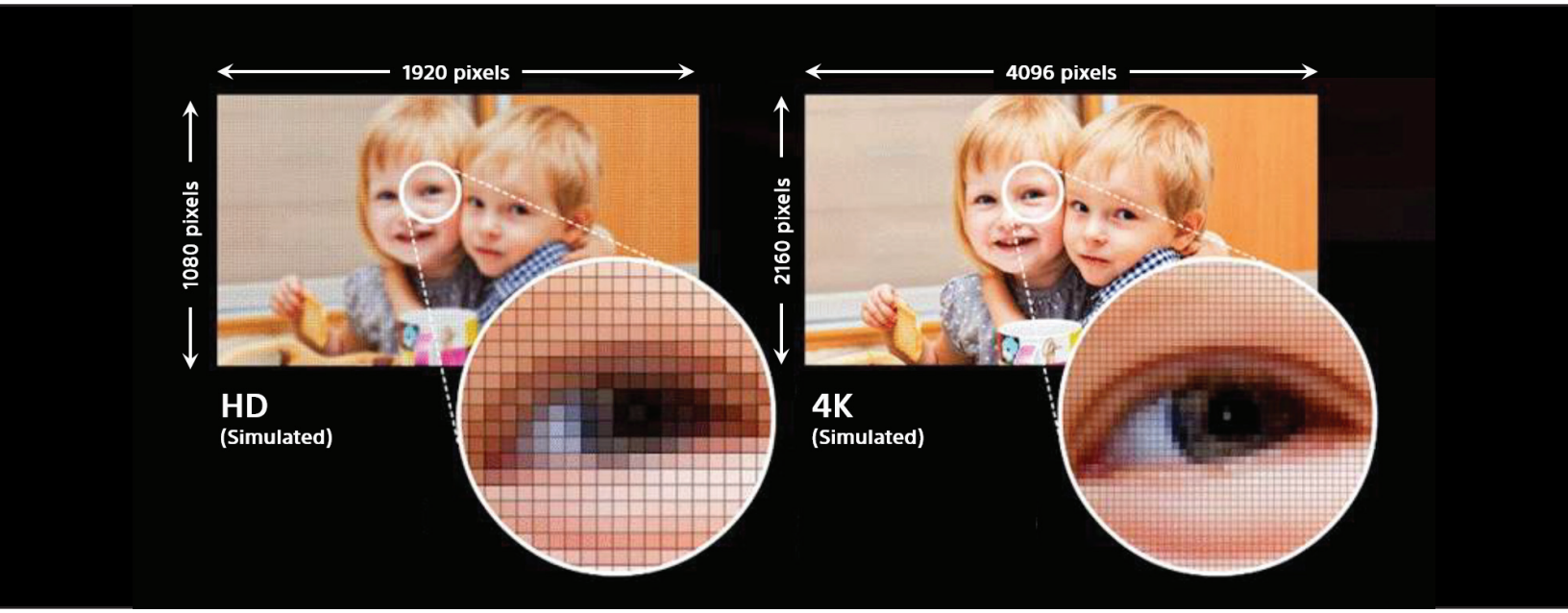
A US quarter dollar, shown actual size (for letter size printout). The pixels of Sony's first generation SXRD chip were so microscopically small that it would have taken about 29,000 pixels to form a rectangle covering the letter "E" in the word "LIBERTY." For the VPL-VW5000ES chip, the pixels are even smaller. It would take about 142,000 pixels to cover the same area.

Key technology #2:
True 4K resolution

In home theater projection, resolution is not some purely academic pursuit. It's a powerful tool to achieve viewer "engagement," a more exciting, more emotionally compelling entertainment experience. Viewing becomes more engaging when you sit closer (for a given screen size) or use a larger screen (for a given viewing distance). Either way, the screen fills more of your field of view.



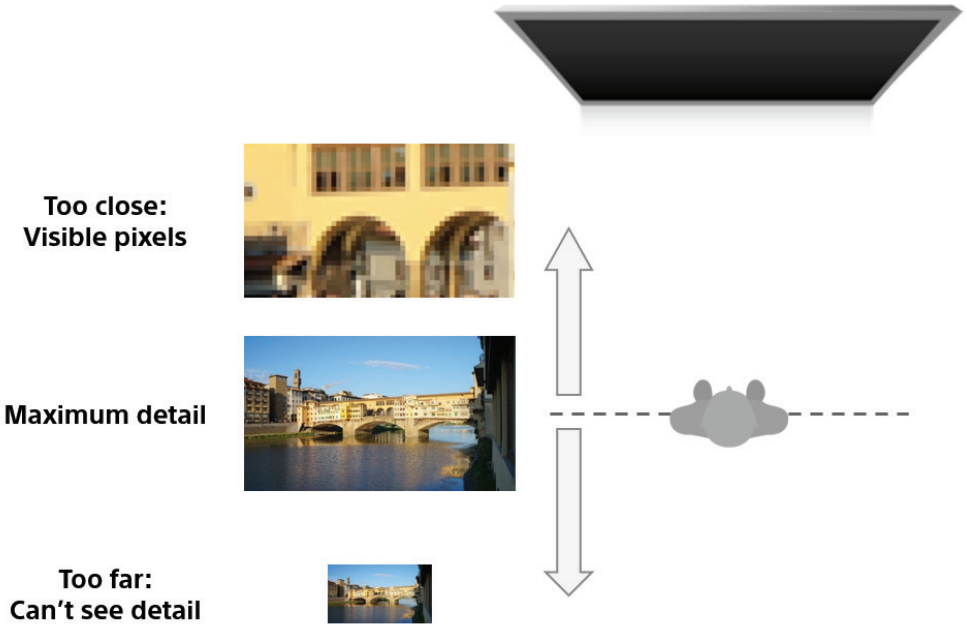
True 4K delivers slightly more than four times the pixels of Full HD. But it's not about numbers. It's about a larger canvas for a more engaging viewing experience.



Compared to HD, 4K Ultra HD images are smoother, more lifelike and more natural.

Greater viewer engagement

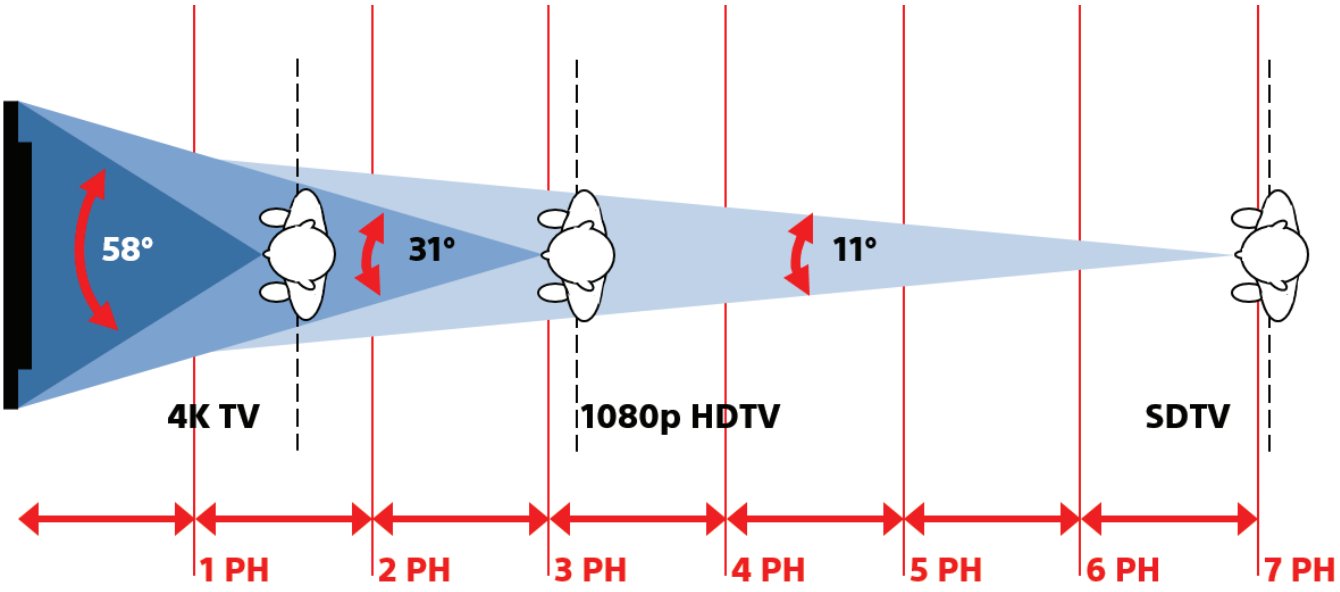
If you like the idea of a more engaging experience and you try to sit closer to a 1080p HD screen, at some point you'll start to see the individual pixels. On-screen objects will become visibly jagged around the edges. The illusion of a seamless picture will begin to fall apart.



> *The "threshold point" is the seating distance at which you're close enough to see the maximum picture detail, but not so close as to discern individual pixels.*

If sitting too close poses a problem, so does sitting too far away. As an extreme example, if we were to watch a typical home theater from a distance of 100 feet, our eyes would certainly not be able to resolve the picture's fine details. The same holds true at less extreme distances. This suggests that there's some "threshold point" at which we can perceive maximum detail, without detecting individual pixels.

Studies of human visual acuity confirm that we can perceive details as small as 1/60 degree (one arc-minute) in the visual field. This works out to 60 pixels per degree. Using this measure and some high-school trigonometry, we can calculate the threshold distance for a given on-screen resolution. We measure this in multiples of the Picture Height (PH).



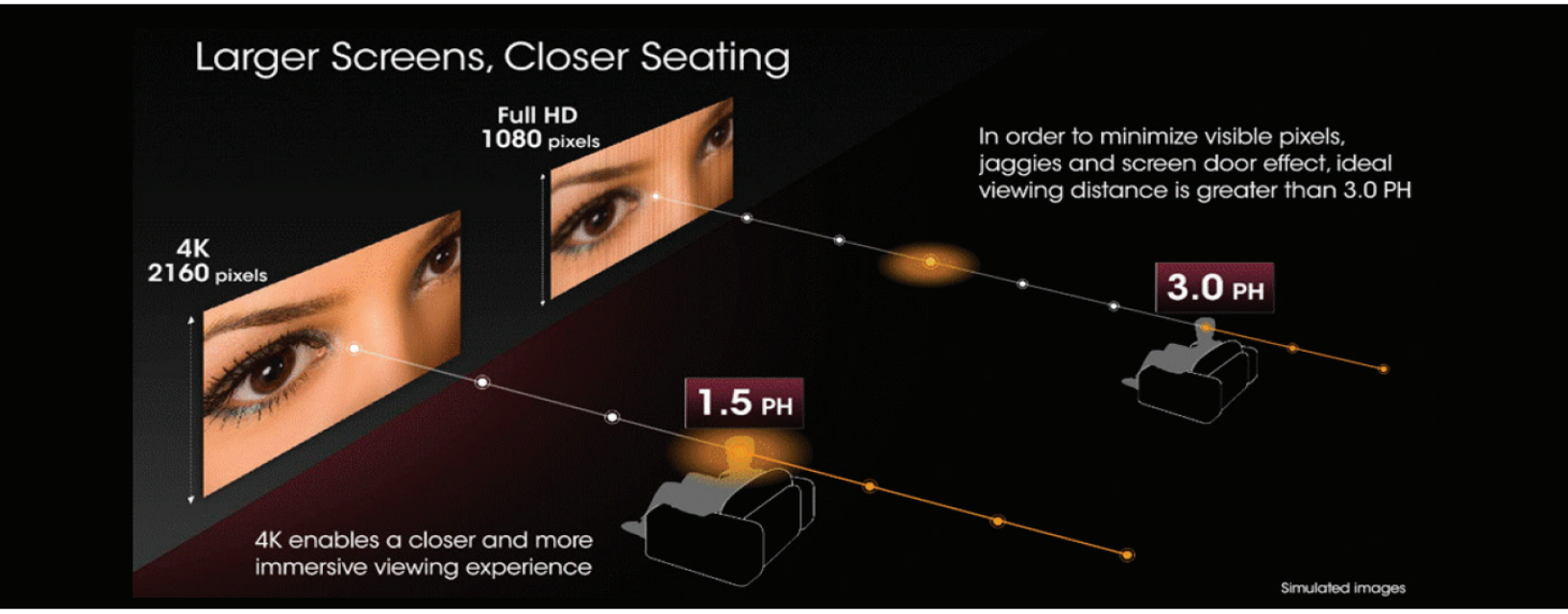
> *SDTV was designed to be viewed from a distance of 7 Picture Heights (PH). HDTV enables you to sit closer and/or watch a bigger screen than SDTV. 4K is even more compelling.*

For SDTV, the threshold distance is 7 Picture Heights (7 PH). This corresponds closely to a 25-inch diagonal screen viewed from 9 feet away. For decades, 25 inches was a best-selling screen size for living room TVs. And studies showed that 9 feet (the "Lechner distance") was the default distance for living room viewing. So the theory matched very well with actual home viewing.

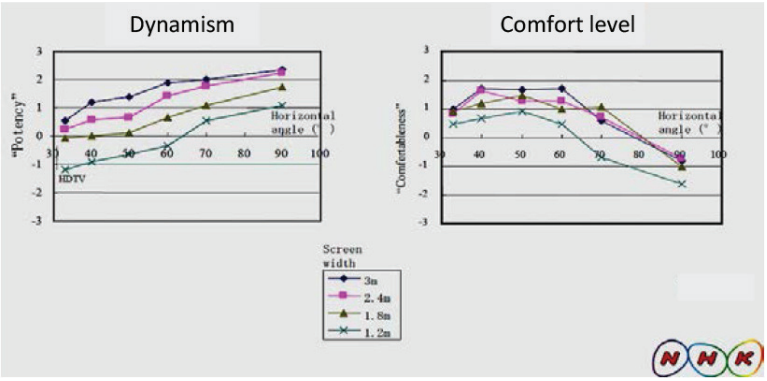
For HDTV, the threshold distance is reduced to 3 PH, a distance at which your entertainment becomes much more immersive. While the SDTV occupied a horizontal angle of 11° when seen from the threshold distance, HDTV occupies an angle of 31°.

While HDTV viewing at 3 PH achieves an immersive experience on a par with classic cinema auditoriums, modern "stadium seating" auditoriums have moved ahead. In stadium seating, 3 PH is near the back row of the auditorium – or even in the projection booth! You need to sit closer than 3 PH for your home theater to reproduce the immersive effect of stadium seating. To avoid visible pixels and screen door effect when you do sit closer, you need higher-than-HD resolution. That's the logic behind 4K Ultra HD home theater.

With 4K Ultra HD, the threshold distance is now 1.5 PH, from which the screen occupies 58° of your visual field. In this way, 4K frees you to sit closer, without visible artifacts. You're more immersed in the entertainment experience, just as in a stadium seating cinema auditorium.



This 1.5 PH number is more than just a back-of-the-envelope calculation. It's been tested by the Science & Technology Research Laboratories of NHK, Japan's national broadcaster. Conducting research with real-world viewers across a range of seating distances and screen sizes, they found the qualities of "dynamism" and "comfort level" were well served at a horizontal viewing angle of 60° -- quite close to our calculated value of 58°. The viewing distance of 1.5 PH is also supported by reports from a global standard-setting body, the International Telecommunication Union (ITU).



NHK research findings on variation in perceived "dynamism" and "comfort level" across different horizontal viewing angles.

Growing momentum for 4K

When Sony built the world's first commercial 4K projector back in 2005, we had to explain that a "K" was 1024 horizontal pixels. We had to detail the interfaces and explain the applications. Today, 4K is a burgeoning standard everywhere from the sound stages of Hollywood to professional sports stadiums to an ever-growing proportion of big-screen televisions and home theaters.

- **Digital Cinema 4K.** In the context of cinema, 4K refers to a container of 4096 x 2160, about 8.8 million pixels. While movie aspect ratios inside the container vary, the container itself has an aspect ratio of roughly 17:9.

- **4K Ultra HD.** In the context of home entertainment, 4K Ultra HD maintains the 16:9 aspect ratio of HDTV. This is 6% narrower than Digital Cinema 4K, with 3840 x 2160, about 8.3 million pixels.

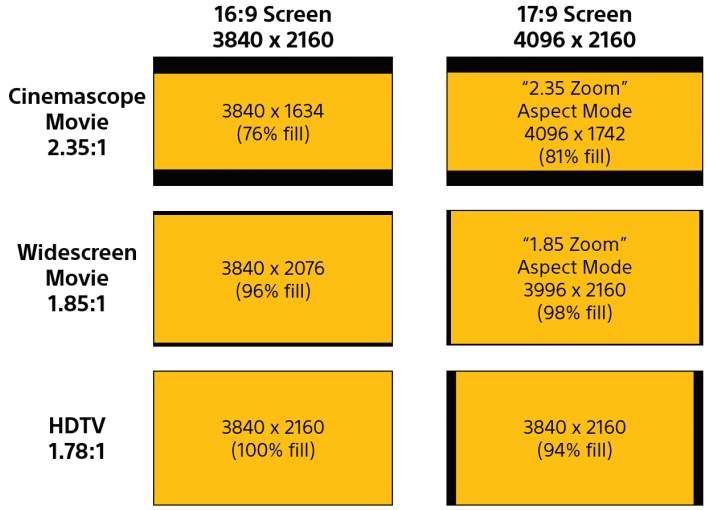
The VPL-VW5000ES supports both resolutions, with native 4096 x 2160 chips.

4K is supported by internationally accepted standards documents, including the International Telecommunication Union's ITU-R BT.2020 recommendation and the corresponding Society of Motion Picture and Television Engineers standard SMPTE ST 2036-1. In the movie theater, 4K is enshrined in the Digital Cinema Initiatives (DCI) specification. 4K Ultra HD is also supported by the Consumer Technology Association, the Blu-Ray Disc Association, the UHD Alliance, High-Definition Multimedia Interface (HDMI) Founders and several other industry groups.

Superior presentation of movies

Mirroring the Digital Cinema Initiatives 17:9 container, the VPL-VW5000ES is optimized for movie presentation. To take maximum advantage of the 17:9 screen, the projector includes "Reality Creation" 4K upscaling and two special aspect ratio accommodation modes. For panoramic movies with the ultra-widescreen Cinemascope® aspect ratio, Sony provides a "2.35 Zoom." This enables the movie to fill more of the screen. The black letterbox bars at top and bottom are smaller.

For the 1.85:1 widescreen aspect ratio that is the default for modern movies, the "1.85 Zoom" setting nearly fills the screen, with very narrow pillar-box bars on the left and right. And conventional HDTV programming also comes close to filling the screen.



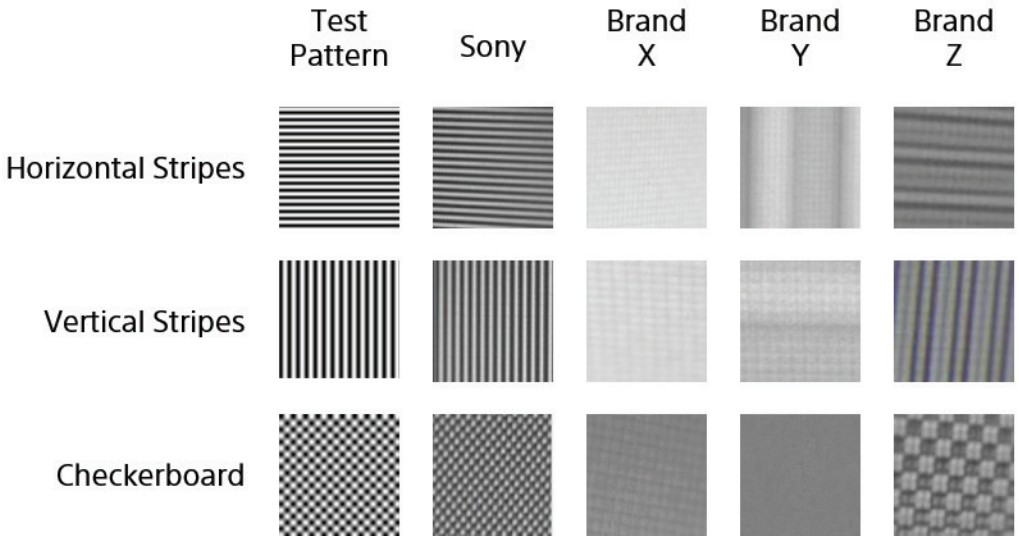
Sony maximizes the use of the 17:9 cinema screen with a choice of Aspect Mode settings and "Reality Creation" 4K upscaling.

Sony and 4K

From broadcast and motion picture cameras to monitors, instant replay servers, broadcast switchers and projectors, Sony is a leader in professional 4K. Over 18,000 digital cinema screens use 4K SXRD projectors from Sony. We have more digital cinema installations in the US than any other brand. We're also a force in consumer 4K with camcorders, 4K-capable still cameras, televisions, home theater projectors and the FMP-X10 home media player, with access to over 200 titles in 4K. Sony's UBP- X1000ES and UBP-X800 Ultra HD Blu-ray players are expected to be available spring 2017.

True 4K, not faux K

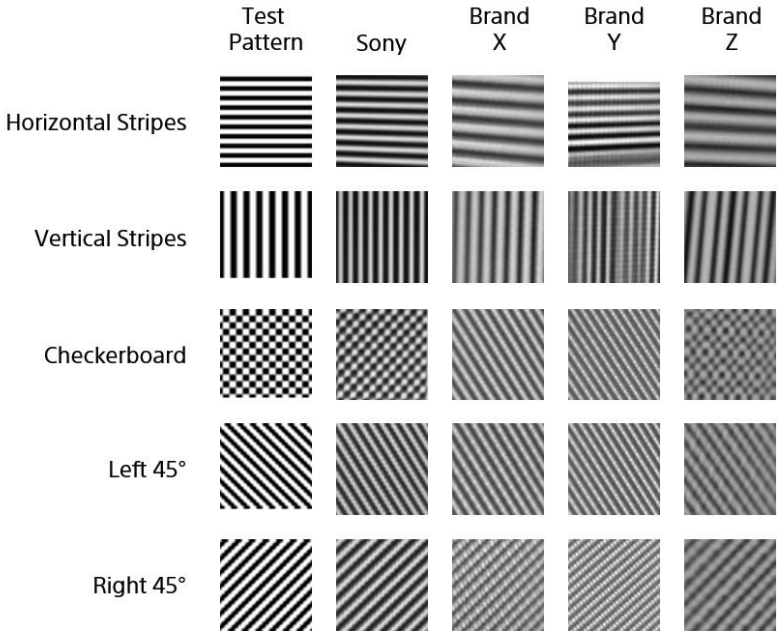
Enabled, as we have seen, by Sony's proprietary SXRD technology, the VPL- VW5000ES incorporates three native 4096 x 2160 microdisplays. This means you get a true 4K picture with full image integrity. There's no pixel shifting, no interlacing, no so- called "enhancement." The same cannot be said for some other home theater projectors that may have 4K inputs but must somehow downconvert the signal because they don't have native 4K microdisplays. They may make some sort of claim to "4K-ness." But look carefully, as we did, and you'll see that some of these solutions fall short.



We sent test images of alternating white and black stripes one pixel wide, plus a one- pixel checkerboard to a Sony 4K home theater projector and three competitors. These are all projectors from major global brands that can input 4K and thereby make some claim of "4K-ness." Then we took high-resolution still images of the projected results. It's no surprise that the Sony projector reproduces the test patterns faithfully, a feat the other projectors can't match.

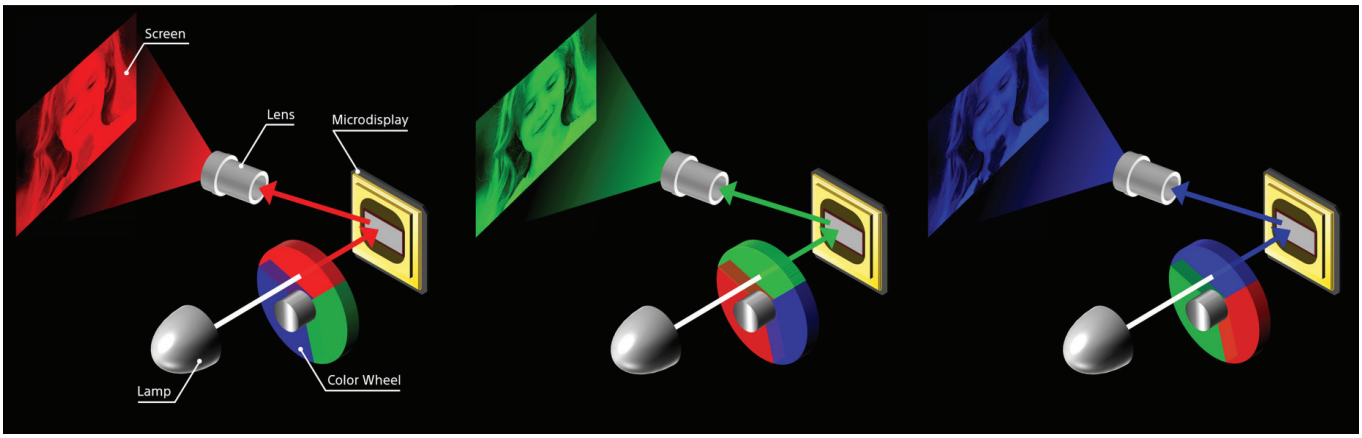
We then repeated the tests with the same projectors and test signals that are two pixels wide, and checkerboard squares that are 2x2 pixels, adding diagonal stripe test patterns for good measure. Even here, on these much less demanding tests, the other projectors had issues.

The test results are not surprising. To project a true 4K image, you need a true 4K projector. While projectors with "shift" and "enhancement" technologies may provide 4K inputs, they are simply not capable of displaying a true 4K image. And if you're asking how Sony can offer true 4K where prominent competing brands do not, the answer is our proprietary 4K SXRD microdisplay. Only Sony manufactures these chips.

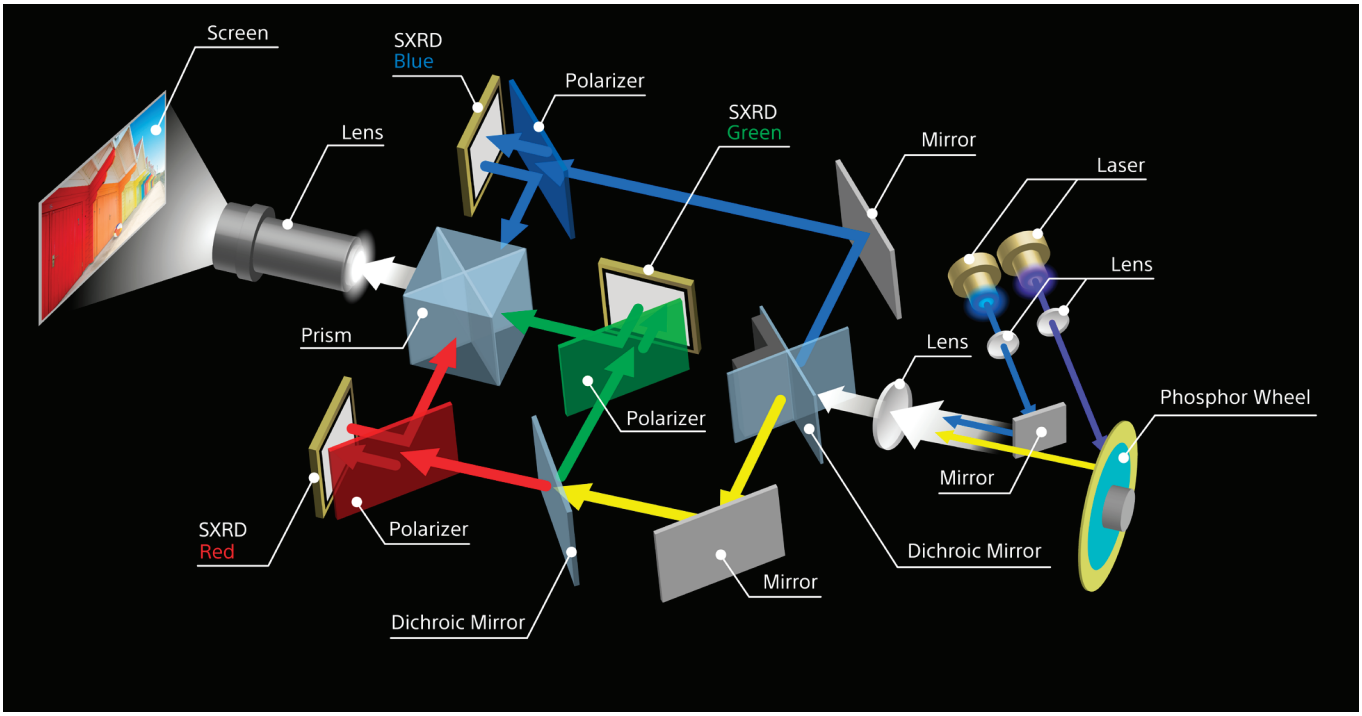


Key technology #3:
3-chip color

Low-end projectors from other brands use a single chip to produce all the on-screen colors. The chip itself can only modulate light intensity. It is essentially monochromatic. The colors are created one at a time via external control of light. For example, in traditional lamp projectors, a rotating color wheel with three or more segments provides Red, Green and Blue light, synchronized to the projection chip's Red, Green and Blue sub-frames. In this system, only one color reaches the screen at a time. Unlike real life, the projector relies on the human visual system to blend all the colors together.



Single-chip projection displays one color at a time, typically Red, Green or Blue.



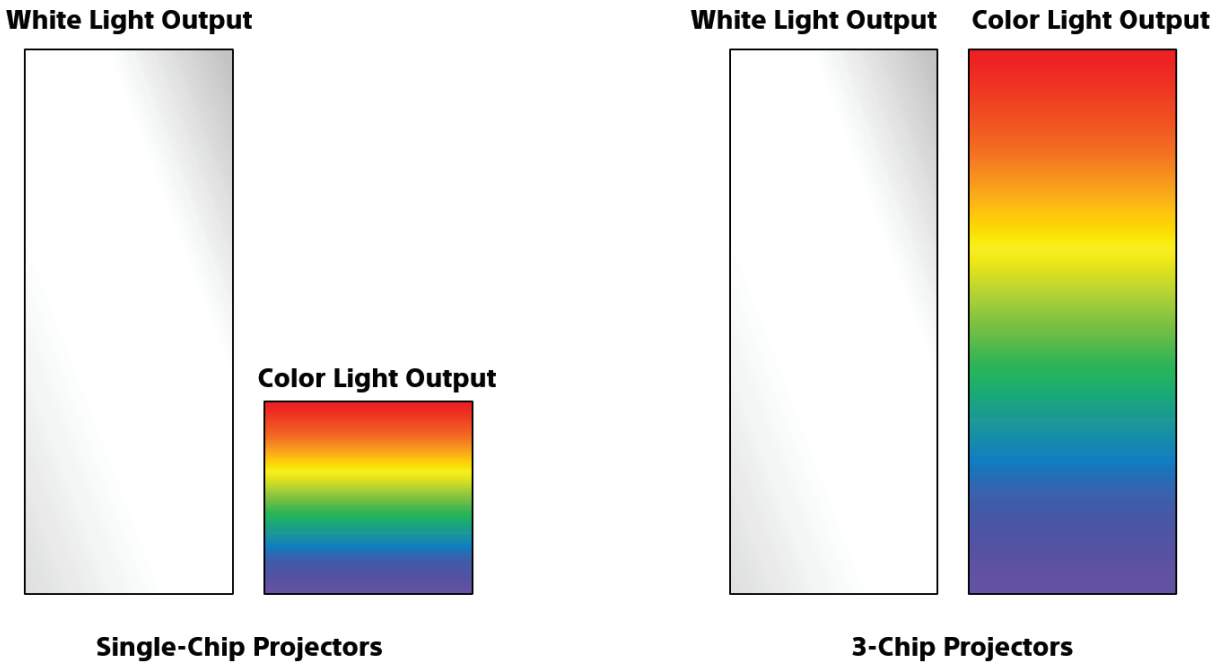
Conceptual view of the 3 SXRD projection system with the Z-Phosphor laser light source. This system displays all the colors, all the time.

In dramatic contrast, nearly every projector used in digital cinema, professional postproduction and ultra-high end home theater uses three separate chips for Red, Green and Blue. And like all of Sony's home theater projectors, the VPL-VW5000ES is a three-chip design. So you see all the colors, all the time. Each pixel on the screen always shows the correct color.

The three-chip system has powerful advantages.

- **Color accuracy.** Projecting all the colors, all the time, 3-chip projectors are known for high color accuracy.

- **Color stability.** Depending on viewing conditions and individual viewer sensitivity, single-chip projectors can reveal “color breaking” and “rainbow” artifacts. These tend to be especially notable on scenes with high contrast and high motion. Because 3-chip projectors display all the colors all the time, they are immune to these artifacts. You get a more continuous, more organic display of color, much closer to life itself.



Single-chip projection color light output is just a fraction of the white light output claimed in brochures and ads. In Sony’s 3-chip system the two measures are identical.

- **Color Brightness.** Projector light output is conventionally measured on an all- white screen – not exactly an accurate representation of home theater viewing conditions. A more realistic (and more demanding) test is color light output, as standardized by the Society for Information Display (SID) in 2012. Unfortunately, the color light output of single-chip projectors is just a fraction of the white light output claimed in typical brochures. For Sony’s 3-chip VPL-VW5000ES, specified color light output (5,000 lumens) is exactly equal to the specified white light output (also 5,000 lumens). As we will see, High Color Brightness is crucial for our next Key Technology: High Dynamic Range.

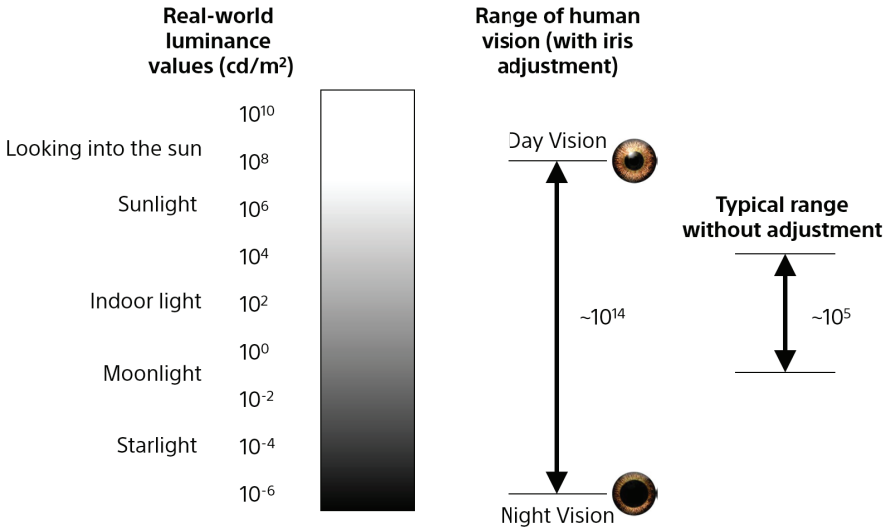
Key technology #4:
High Dynamic Range (HDR)

If 4K is about more pixels, then HDR is about better pixels. In audio, "dynamic range" defines a system's breadth of reproduction from the softest possible sounds (limited by the noise floor) to the loudest (limited by the distortion ceiling). In video, it's the breadth of reproduction from the darkest possible black to the brightest possible highlight.

Compared to conventional, Standard Dynamic Range (SDR), HDR delivers home entertainment with unprecedented immersion and impact. Just as anyone who has experienced high definition is spoiled for standard definition, once you've seen a proper demonstration of HDR, you'll never want to look back.

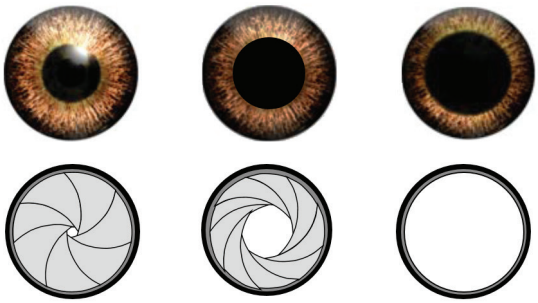
SDR falls short of human vision

The human visual system is incredibly versatile. We can perceive light values from 10^{-6} candelas per square meter (cd/m^2) for starlight all the way to 10^8 cd/m^2 for direct sun. That's a ratio of 100,000,000,000,000:1. This is essentially our "dynamic contrast ratio." However, "simultaneous contrast ratio" is another matter.



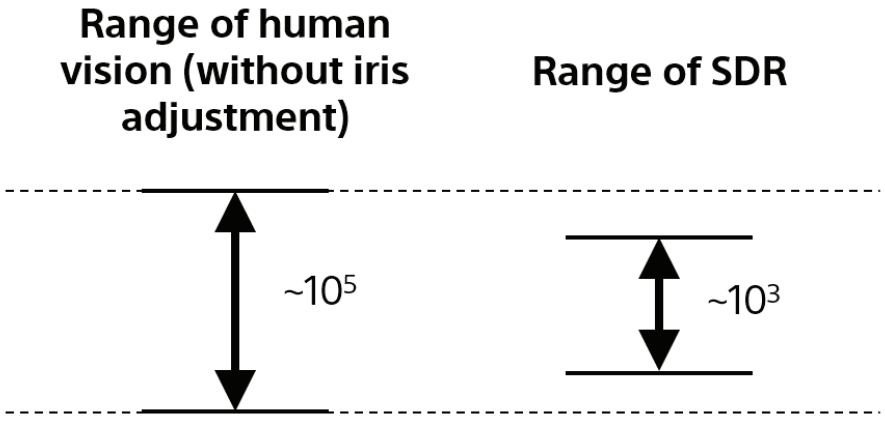
> *To accommodate the range from starlight to sunlight, the irises in our eyes need to adjust. At any given instant, the human visual system can "only" accommodate a luminance range of 10^5, Think of this as a "simultaneous contrast ratio" of 100,000:1.*

To accommodate such a broad range of light levels, the irises in your eyes need to adjust, a process that takes some time. Like the human eye, television and cinema cameras also have adjustable irises that operators use to accommodate the difference from daytime to nighttime light levels.



> *Like the iris in the human eye, the mechanical iris in the camera's lens adjusts to accommodate the huge variations in light levels from day to night.*

Within a single scene, the human visual system's dynamic range is far more limited, on the order of 100,000:1. Even this narrower range is beyond the reach of conventional television technology. Early television cameras couldn't capture 100,000:1. CRT televisions couldn't display 100,000:1. They were limited to a maximum brightness of just 100 nits (100 cd/m2). Analog TV broadcasting, 8-bit digital recording and 8-bit HDTV broadcasting can't preserve all the nuances of a 100,000:1 image. For all these reasons, conventional, SDR reproduction has been stuck with a dynamic range closer to 1,000:1.

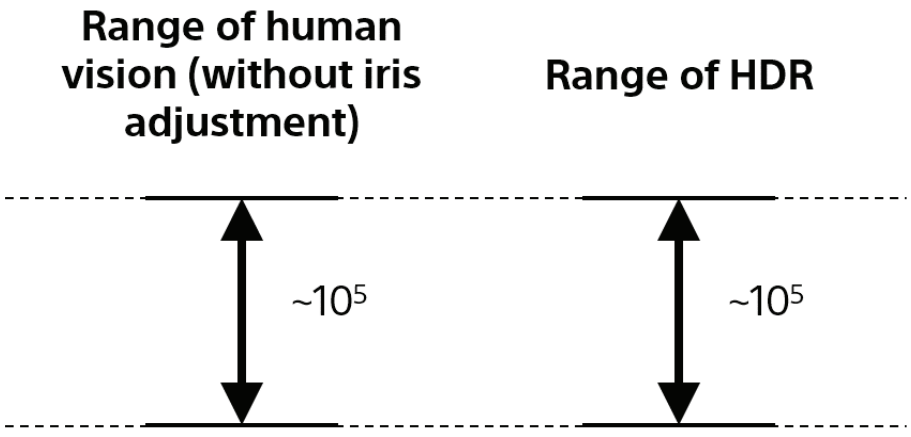


SDR television systems can't match the dynamic range of the human visual system.

The HDR opportunity

Since the 1950s, a suite of technical advances has made the limitations of SDR increasingly obsolete. For the first time, it is now practical to create an end-to-end television system that comes close to reproducing the human visual system's 100,000:1 capabilities. This is High Dynamic Range.

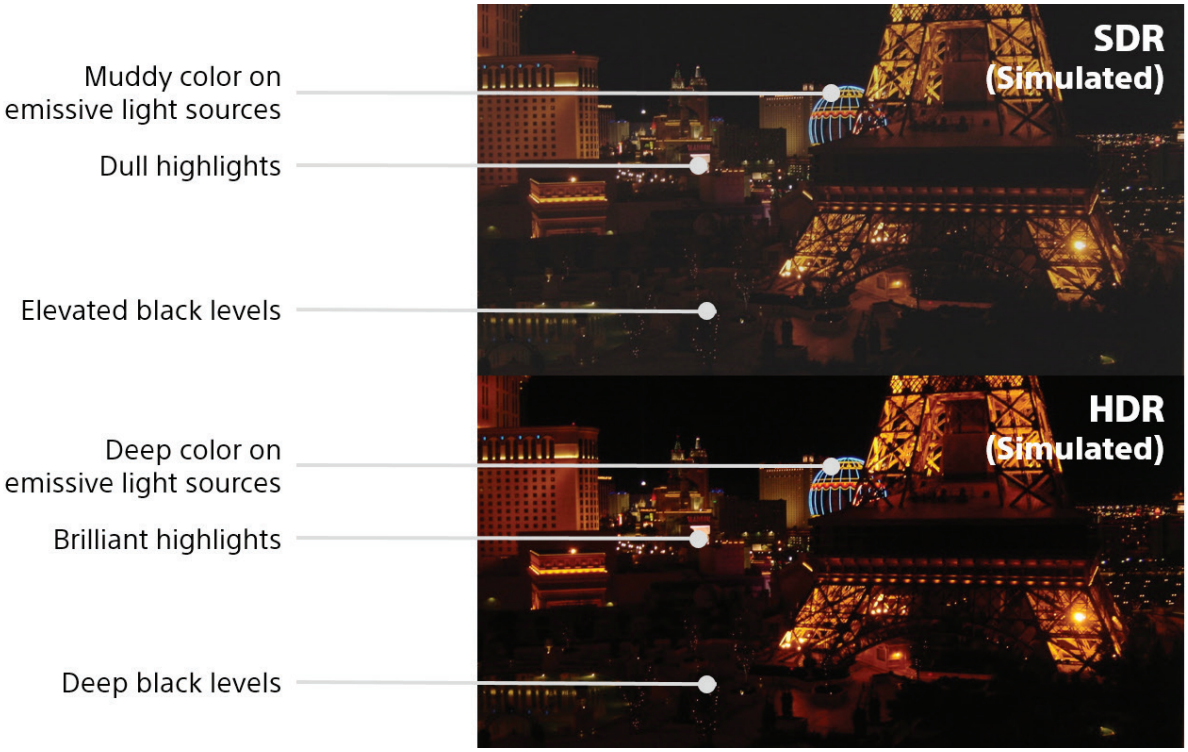
The current generation of digital motion picture and TV broadcast cameras can capture HDR. The current generation of professional digital recorders feature 10 bits or more of precision, capable of recording HDR. The very latest professional monitors, such as Sony's BVM-X300, enable directors and cinematographers to evaluate HDR images on- set during the shoot and also during critical postproduction processes such as color grading. New display technologies can deliver HDR to movie theaters, home theaters and televisions. For the first time, HDR can convey this entire 100,000:1 range all the way from the camera set through to the viewer.



HDR preserves the 100,000:1 range of human vision.

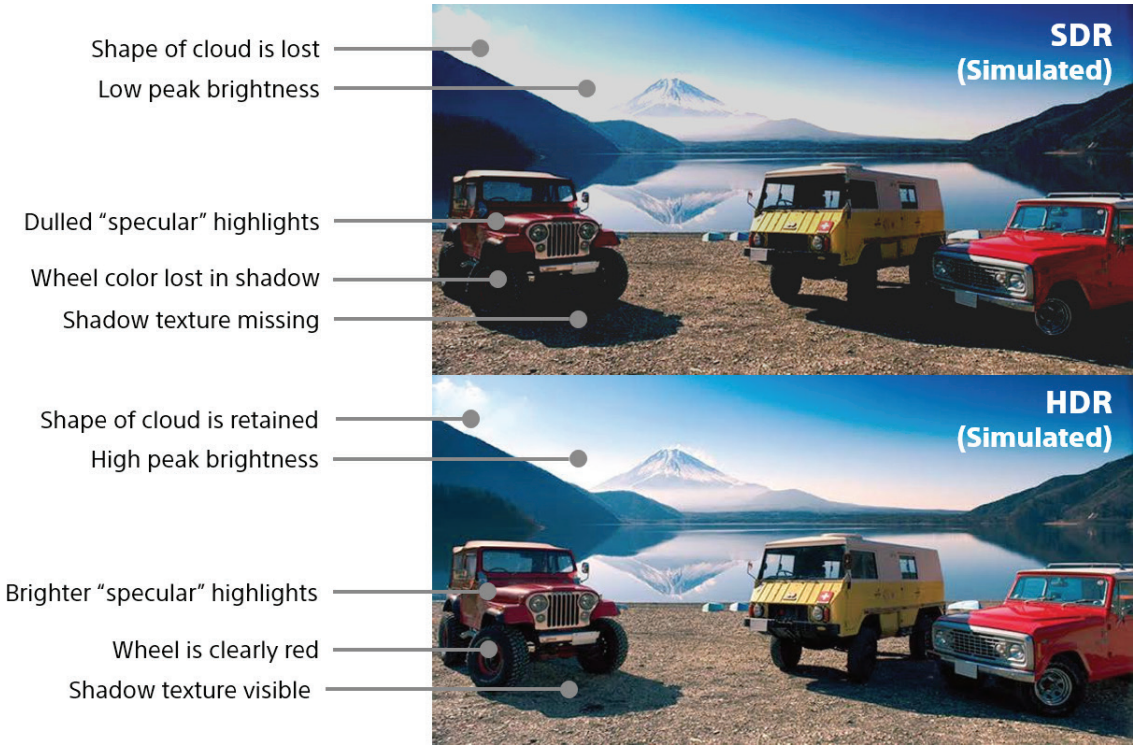
HDR benefits

HDR benefits almost every type of content, from cinematic drama to TV sports.

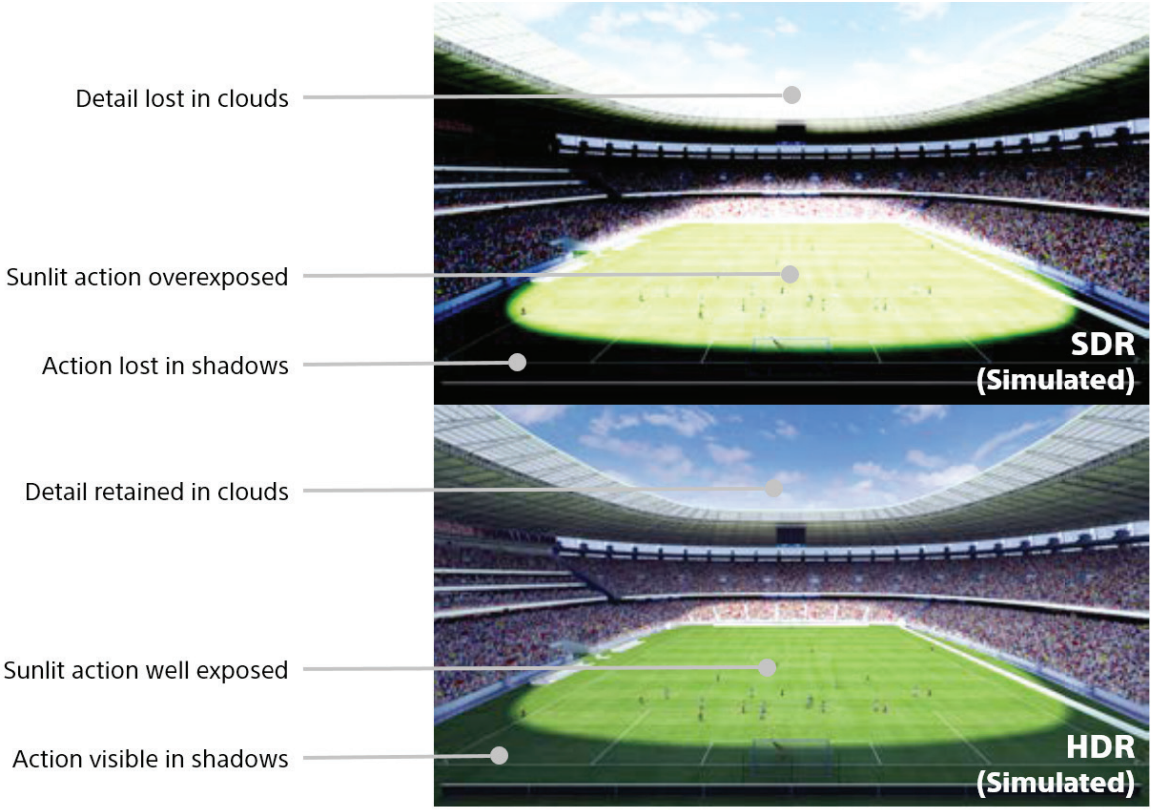


Nighttime cityscapes are a classic demonstration of HDR. A proper presentation of this effect would require HDR authoring and HDR viewing, conditions that do not apply here. The best we can provide are simulated images that can only give you a rough idea of the true comparison.

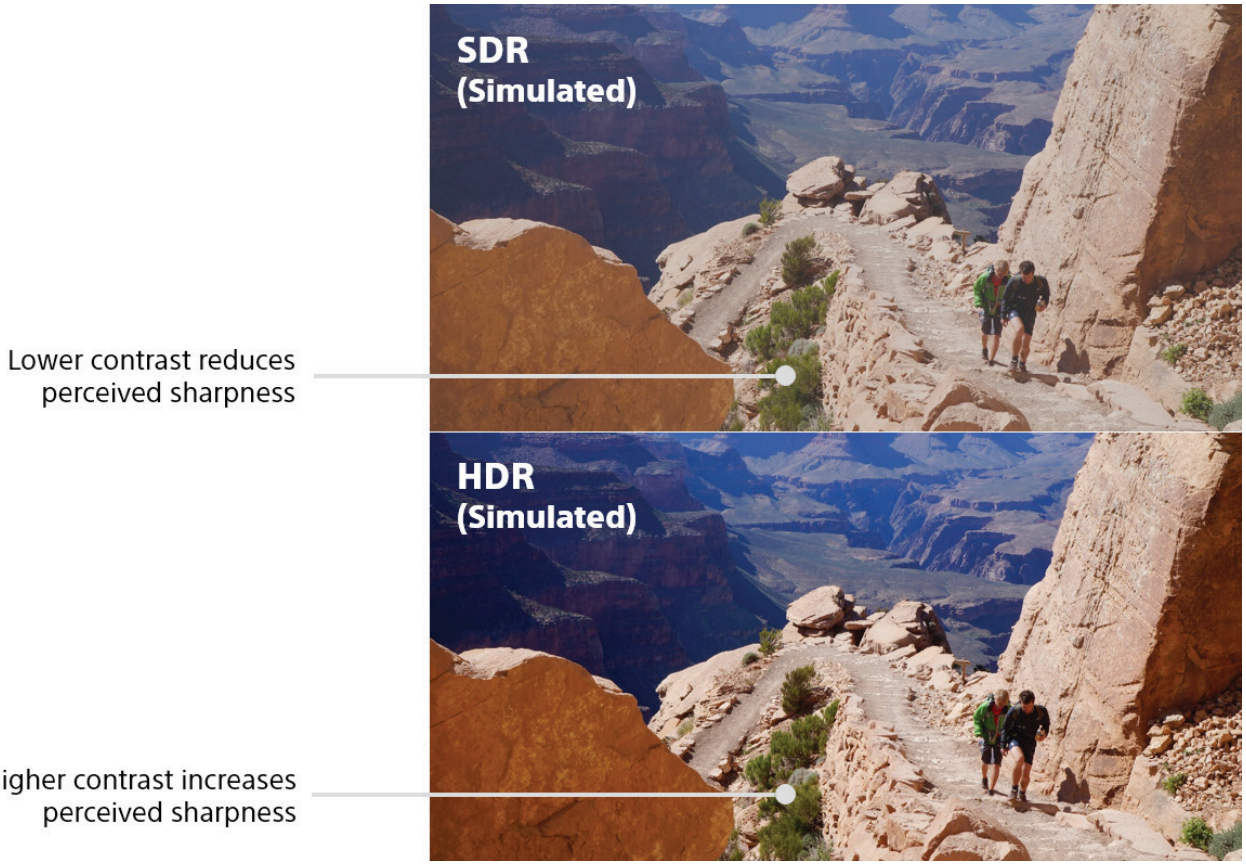
- **Greater impact.** Compared to HDR, SDR is a pale imitation of life. We've seen that SDR falls far short of the contrast you experience in real life, while HDR can achieve that contrast. Images become more vibrant, more compelling and more involving. The advantage is most obvious in scenes with dynamic extremes: fireworks, pyrotechnics, sunsets or city skylines lit up against a deep black night sky. You see blacker blacks, higher peak brightness and better tonal gradations in between.
- **More information.** With SDR, detail is in constant danger of being lost in the darkest and brightest areas of a scene. Professionals call these losses "crushed blacks" and "clipped highlights." The limitations of SDR force content creators to constantly squash scene dynamic range to fit into the constraints of the narrow SDR distribution pipeline. In scripted productions such as movies and episodic TV shows, the process of color grading often squashes the range to ensure that the SDR distribution master retains important storytelling details in highlights and shadows. But live productions, such as TV sports, don't have that luxury. When the action moves from stadium shadows into bright sunlight, the picture momentarily becomes overexposed. That's because an SDR camera properly exposed for shadows, can't cope with bright sunlight. We can't follow the action until a broadcast technician adjusts the camera's iris. With HDR, no adjustment is necessary. HDR can deliver the entire event from shadows to highlights seamlessly.



This pair of simulated images illustrates how SDR clips highlight details and crushes black details that HDR retains.



In these simulated images of live sports, the SDR broadcast can’t accommodate the dynamic range from in bright sunlight to stadium shadow. The HDR broadcast can.



In these simulated images, the resolution is identical. Only the difference in contrast accounts for the higher perceived sharpness.

- **Greater sharpness.** Distinct from resolution, "sharpness" describes the subjective impression that an image creates. Achieving high sharpness requires both high resolution and high contrast. Because HDR enables a significant boost to reproduced contrast, picture details will "pop" as never before. Images will be crisper and more lifelike.

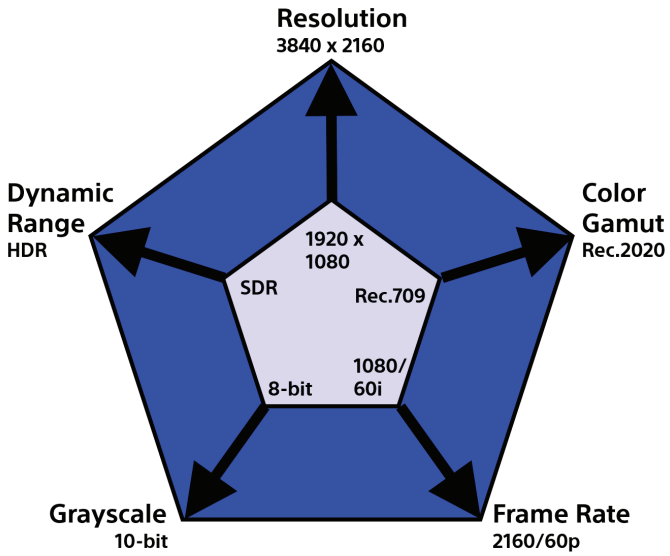
Sony built the VPL-VW5000ES to take advantage of all these benefits. Thanks to the high brightness of 5,000 lumens, high contrast ratio and the ability to accept HDR inputs, the projector is ready. If you supply proper HDR source material and operate the projector in a proper environment, the image is absolutely staggering.

The VW5000ES also incorporates operating refinements that make it easy to get the most out of the HDR experience.

- **HDR Auto Mode** automatically detects the digital flag that identifies HDR content (as well as the companion BT.2020 color gamut). The projector automatically switches to HDR settings. So you automatically get the correct settings, whether you're watching SDR or HDR.
- **HDR Contrast** adjusts contrast level for HDR independently from your SDR setting. You get satisfying on-screen brightness and contrast for all your content.
- **On-Screen Display.** To confirm what you're watching, we've also added HDR indication to the Signal Type field in the Information page of the On-Screen Display.

HDR companion technologies

Accompanying HDR is a substantial portfolio of image enhancements. In addition to 4K Ultra HD resolution, options available to cinema and television producers include Wide Color Gamut, improved grayscale rendition and High Frame Rate.



HDR is not about any single specification. It marks a simultaneous improvement in five key aspects of picture quality.

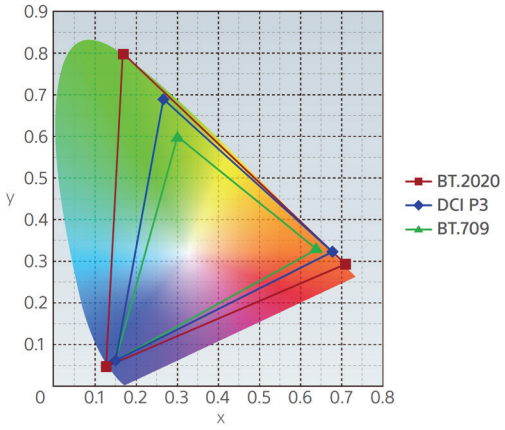
These quality improvements work in concert, particularly 4K Ultra HD resolution and HDR. So you're not just getting more color gradations, you're also getting more pixels on which to apply them. HDR and 4K work synergistically to deliver more organic images – a picture more like life itself.

Wide Color Gamut with BT.2020 emulation

Constrained by CRT television phosphors and tube-equipped television cameras, SDTV had a limited range or "gamut" of possible colors. This means that subjects with the deepest, most saturated green, yellow, orange, red and violet appear muted or muddied. This can degrade the reproduction of both natural colors (flowers) and artificial colors (neon lights) as well as other emissive sources (volcanoes, sunsets). The CIE chromaticity chart is a two dimensional plot that shows every visible hue. In RGB reproduction systems, the gamut forms a triangle defined by the Red, Green and Blue primaries at each corner. Surprisingly, the digital SDTV color system standardized by the International Telecommunication Union, ITU-R BT.601 (called BT.601 or Rec. 601 for short) occupied a CIE chromaticity triangle that covers only about 36% of visible hues.

Because CRTs were still the dominant display technology during the development of HDTV, the HD color range was no larger. The HD color gamut defined by ITU-R BT.709 (Rec. 709) was no more extensive than the SDTV gamut.

The HDTV color gamut, ITU-R BT.709 color (inner triangle) covers only about 36% of visible colors. The Digital Cinema Initiatives P3 gamut (middle triangle) is larger. Ultra HD ITU-R BT.2020 color dwarfs them both, covering about 76% of visible colors.

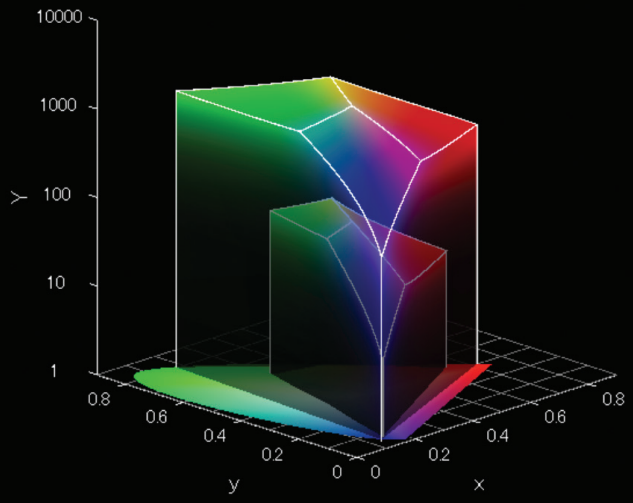


The development of plasma and OLED flat panel displays plus the availability of LCD displays with a dazzling range of backlight technologies have opened up a new world of color reproduction. On the digital projection side, new light sources and filters have also enabled superior color. It was to overcome previous limitations and to anticipate future improvements in display technology that the ITU specified a far greater range of color for 4K Ultra HD. The Rec. 2020 standard more than doubles the range of reproducible colors. Compared to SDTV (Rec. 601) and HDTV (Rec. 709), both of which deliver 36% of visible colors, the Rec. 2020 gamut covers 76% of visible colors.

Connect a compatible source and you'll see flowers, foliage and other natural colors with newfound realism. You'll notice the difference in the most saturated greens, yellows, oranges and reds. Emissive light sources, particularly fire, lava and neon lights, will appear on-screen as never before.

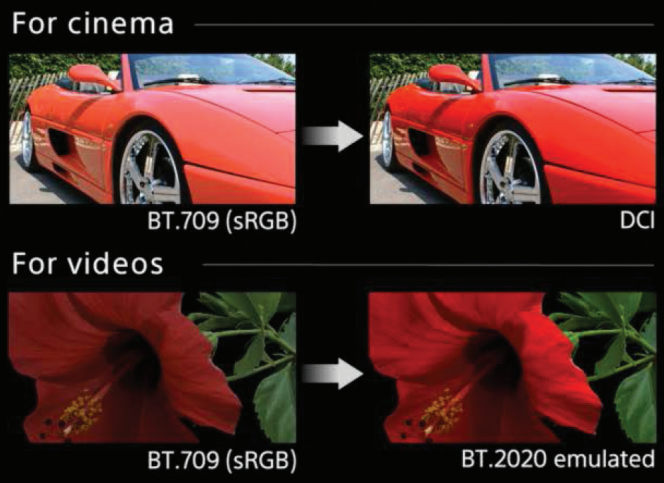
And the CIE chromaticity chart only tells part of the story. It says nothing about reproducing colors across the range from dark to light. To do that, we need to add another dimension, going from color "area" to color "volume". In terms of color volume, the difference between HDTV and 4K Ultra HD is staggering.

Because HDR combines wider color gamut with higher peak brightness, you not only get a wider color area. You also get greater color volume with the vertical axis representing peak brightness in nits (cd/m²). This chart compares 100 nit Rec. 709 and 1,000 nit Rec. 2020 direct view displays, but the concept also applies to the VPL-VW5000ES projector.



TRILUMINOS DISPLAY

Thanks to Sony's TRILUMINOS® Display color system, the VPL-VW5000ES color gamut extends far beyond BT.709. An Auto Color filter engages to increase the projected gamut. In this way, the projector covers 100% of the Digital Cinema Initiatives P3 color gamut and the overwhelming majority of the BT.2020 color gamut.



The projector enhances color with DCI P3 reproduction and BT.2020 Emulation. (Images simulated.)

To take full advantage, the projector includes color remapping modes that enhance the color expression of conventional BT.709 sources. DCI P3 reproduction for motion pictures and BT.2020 Emulation for 4K UHD deliver deeper, more saturated color optimized for whatever you're watching.

Improved grayscale rendition

In theory, we could imagine an HDR video system with one-bit encoding. A digital 1 could represent white, while a digital 0 could represent black. In practice, we need our video pictures to represent grayscale values between peak white and black. And that requires more bits. Conventional HD recording systems, HDTV broadcasting and conventional Blu-ray Disc all represent images with 8-bit digital samples.

While careful observers will sometimes see issues, under most circumstances these 8- bit samples are sufficient to represent SDR images. But when you try to squeeze HDR images into an 8-bit pipeline and then stretch HDR back out on the screen, problems appear. Tonal gradations that should appear smooth and continuous become visibly stair-stepped. The problem, called "banding" or "posterization," is bad enough on still images. On moving pictures, it can be extremely distracting. So along with High Dynamic Range, 4K Ultra HD can also deliver higher bit depth, such as 12-bit image capture and distribution. Because major HDR distribution channels are opting for 10-bit, our discussion will focus on that.

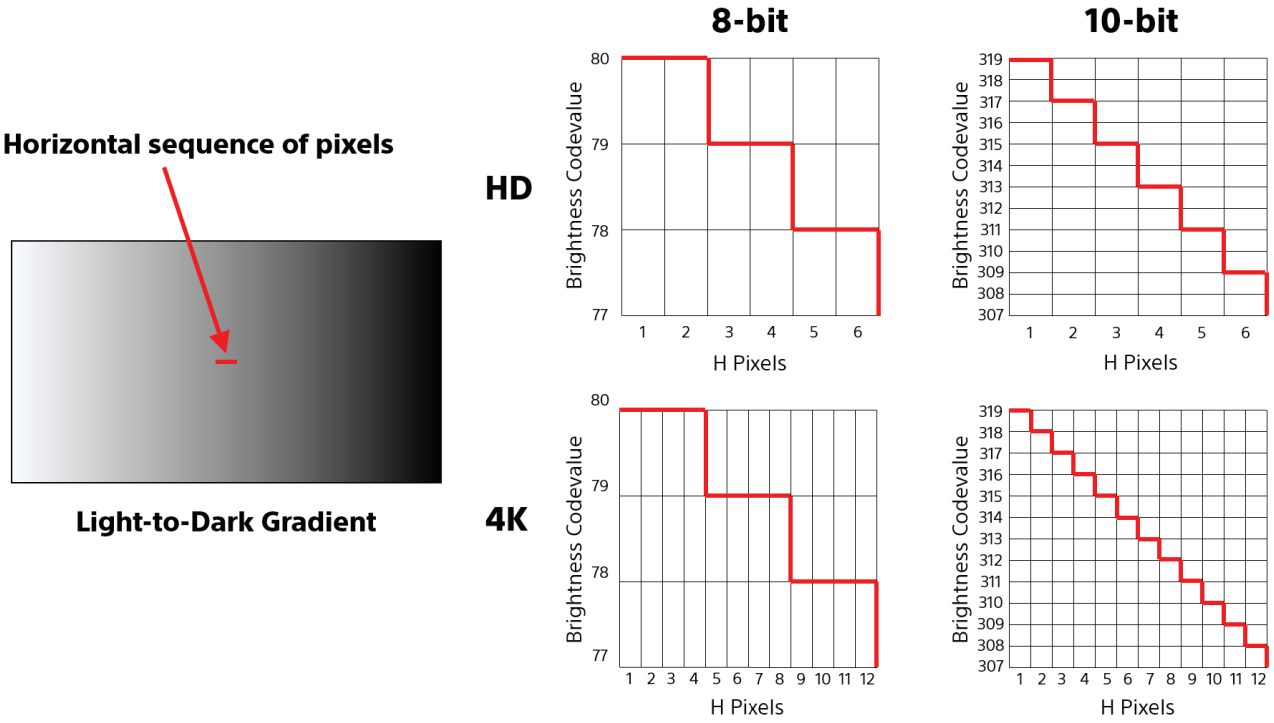
In these simulated images, insufficient grayscale rendition (left) causes horizontal banding in the sky. This artifact is absent in the image on the right.

In digital pulse code modulation, each additional bit of accuracy doubles the number of available quantization levels or "codelevels" available in the three channels: black-and-white luminance (Y), blue color difference (C_b) and red color difference (C_r). While 8-bit video has about 250 codelevels per channel, 10-bit video increases that to about 1000 codelevels.

HDR not only increases the number of codelevels, but can also improve their efficiency. SDR video is tied to gamma encoding, a system created to compensate for the characteristics of 1950s era cathode ray tube televisions. HDR can replace gamma with approaches better matched to the needs of the human visual system. These include Perceptual Quantization (PQ) and Hybrid Log Gamma (HLG).

The combination of HDR, wide color gamut and 10-bit quantization enables far more accurate rendition of grayscale. If you're not a professional photographer, it may be hard to appreciate how important this is. When photographers and cinematographers light a scene, they're looking for much more than adequate exposure; they're "painting with light." Cinematographers use lighting to show the viewer where to look in the frame. Lighting also helps convey emotion, defining moments of terror, intimacy, conflict and peace.

SDR tends to oversimplify these subtle gradations, flattening faces and muting the intended emotional impact. For cinematographers, HDR provides a vastly expanded canvas on which to tell stories. For audiences, HDR provides a more immediate, more immersive, more emotionally compelling entertainment experience. The combination of 10-bit grayscale and 4K Ultra HD resolution results in powerful synergies. Expanded grayscale offers a wider range of brightness levels while 4K provides more pixels across which to paint those levels.



The combination of 10-bit grayscale and 4K resolution is particularly powerful. On the left is an image that starts with peak white at the left, fading to full black at the right. Consider a horizontal sequence of a few pixels in the middle. Each pixel has brightness recorded as a digital codevalue. The higher the codevalue, the brighter the pixel. With the picture rendered in 8-bit HD (upper left chart), the scarcity of brightness steps equates to a gradation that's somewhat rough. Simply increasing the resolution to 4K (lower left chart) does nothing to improve this gradation. 10-bit HD is somewhat better (upper right). But the smoothest gradation is clearly 10-bit 4K (lower right).

The VPL-VW5000ES is primed to take full advantage of HDR content distribution. The projector has two HDMI 2.0 inputs with a maximum data rate of 18 Gigabits per second. In HDR mode, the projector accommodates signals of 3840x2160 resolution and 10-bit or 12-bit quantization at frame rates of 24p, 25p, 30p, 50p and 60p.

High Frame Rates (HFR)

For an additional measure of you-are-there realism, High Frame Rates can make a big difference. Almost all movies are shot at the relatively low rate of 24 frames per second (fps). Conventional HDTV offers a choice: maximum resolution or maximum frame rate. For maximum resolution, most US television broadcasting takes place at 1080/60i. Which means you get 60 half-frames (fields) per second, but only 30 complete frames per second. While 1080/60i renders motionless backgrounds in great detail, the frame rate can add blur to moving parts of the image.

Other US broadcasters have opted for maximum frame rate, in order to render motion as smoothly as possible. By broadcasting at 720/60p, they deliver 60 complete frames per second, which can be a benefit for TV sports.

Introduced in 2015, Sony's Emmy® Award winning HDC-4300 became an instant hit with sports broadcasters by combining HFR and 4K Ultra HD together with the ability to accept standard broadcast lenses.

With 4K HFR, there's no reason to choose. You can get high resolution and high frame rates at the same time, with 2160/60p. That's eight times the information of either 1080/60i or 720/60p. This is incredible resolution on both still and moving parts of the image.

This soccer ball simulates motion blur. Higher frame rates render motion with more intermediate steps. Although shutter speed is a creative choice, higher frame rates are also associated with the faster shutter speeds that minimize motion blur.

Some Hollywood directors are eager to adopt High Frame Rates in the movie theater while others remain cool to the prospect. Opinions differ at the movies, but there are other entertainment platforms where High Frame Rates are gratefully accepted: videogames and televised sports.

- **HFR videogames** represent a major leap forward in immersion and pulse-pounding excitement. Scenes are rendered with heightened detail. And even the most frenetic action appears smooth and sharp.
- **4K/60p sports** are breathtaking. You can survey the entire football field, sideline to sideline and read all the players' names. When athletes spring into action, they remain free from motion blur.

HDR and creative intent

An engineer might imagine that the purpose of home entertainment is to recreate the original scene as accurately as possible. To this way of thinking, HDR, better grayscale rendition, higher frame rates and wider color gamut are all indisputable advantages, slated for use on every occasion.

It's important to note that cinematographers and directors don't think like engineers. Depending on the story, moviemakers may deliberately choose to shoot in black-and-white, ignoring color gamut altogether. And while higher frame rates can be more "lifelike," lifelike is not always the top priority. Many cinematographers continue to be passionately loyal to 24 fps, a standard that dates to the 1920s.

HDR and its associated advances in color gamut, grayscale rendition and frame rate all empower creative artists with a new range of choices. You can think of these advances as new tools in the creative toolkit, new keys on the piano keyboard or even new colors in the artist's palette. While some directors will leap at the opportunity to use these new tools for all they're worth, others may use just one or two. It all depends on creative intent.

The HDR entertainment ecosystem

Until recently, the entire infrastructure of motion imaging – both for the cinema and the home – had been built on the basis of Standard Dynamic Range. This means Digital Cinema, HDTV broadcasting, DVD and conventional Blu-ray Disc were all designed around SDR.

To get the best out of HDR, you need content that was captured in HDR, color graded in HDR, distributed in HDR and displayed in HDR. The entertainment industry is moving rapidly to make the complete HDR production and distribution chain a reality.

- **HDR cinema.** In the movie theater, the Digital Cinema Package (DCP) that studios send into the theater can accommodate HDR. And the first HDR capable projectors are being installed into theaters.
- **Over-the-top HDR streaming.** Sensing an opportunity to stake a claim on the frontiers of picture quality, streaming services have been eager to exploit the potential of HDR. Popular services including Netflix, Amazon Prime and Vudu are already producing and distributing highly promoted original series in HDR.

- **HDR packaged media: Ultra HD Blu-ray.** Standardized in May 2015, Ultra HD Blu-ray embraces Ultra HD (3840 x 2160 resolution), the BT.2020 color gamut, High Frame Rates and HDR with 10-bit grayscale encoding. Sony's UBP-X1000ES and UBP-X800 Ultra HD Blu-ray players are expected to be available spring 2017.

- **HDR videogame consoles.** Both Sony's PLAYSTATION® 4 Pro and the Microsoft® Xbox® One S consoles support 4K HDR gaming. Every aspect of HDR can benefit game play. Improved sharpness, frame rates, contrast and color gamut all add excitement to white-knuckle experiences.

Sony's PLAYSTATION 4 Pro entertainment console supports 4K Ultra HD, HDR and High Frame Rates.

- **Over-the-air HDR broadcasting.** In the United States, HDTV broadcasting resulted from a mandate by the Federal Communications Commission. To date, there is no such mandate for either 4K Ultra HDTV or HDR. However, a technical standard for next-generation broadcasting, called ATSC 3.0 is in development and testing. Several candidate HDR technologies are currently being considered.
- **HDR satellite broadcasting.** In the US, the satellite TV companies have not announced HDR plans yet. So stay tuned.

Key technology #5:
5,000 lumens brightness

Proper presentation of HDR calls for higher peak brightness levels. HDR is designed to provide high peaks for small areas of the screen that may show car headlights at night or sunlight reflecting off windows. (Brightness for full screen white can be considerably less.)

To deliver the full benefit of HDR, the VPL-VW5000ES combines superlative picture quality with high brightness: 5,000 lumens white light output and 5,000 lumens color light output. The brightest of Sony's home cinema projectors, the VW5000ES is ideally equipped for HDR presentation.

According to the Society of Motion Picture and Television Engineers SMPTE 196M standard, screen brightness for movie theaters should be 16 foot-Lamberts, which equals 55 cd/m2 also called 55 "nits." Until recently, the rule-of-thumb for screen brightness in a darkened-room home theater has been in the same range: 12 to 22 foot- Lamberts (41 to 75 nits).

The VW5000ES peak brightness can far exceed these light levels. Actual brightness will depend on operating conditions, screen size, screen gain and several other factors. The following chart shows gross brightness for screens of gain 1.0.

Screen Gain	Screen Width	Peak Brightness	SDR rule of thumb
1.0	10.0 feet	325 nits	41 to 75 nits
1.0	12.5 feet	208 nits	41 to 75 nits
1.0	15.0 feet	144 nits	41 to 75 nits
1.0	17.5 feet	106 nits	41 to 75 nits
1.0	20.0 feet	81 nits	41 to 75 nits

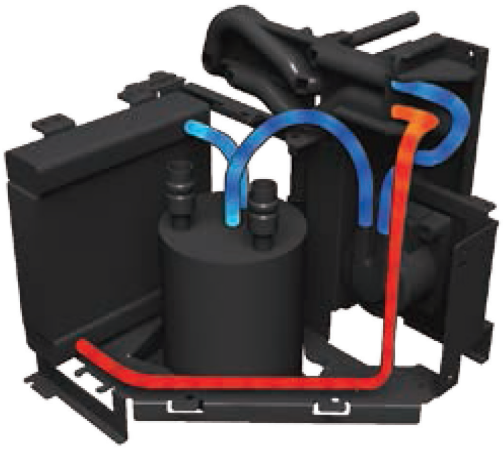
How you use it is up to you.

While many owners will use the high brightness of the VW5000ES in the service of HDR, others may choose to go for larger screens or clear viewing even in ambient light.

Performance you can live with

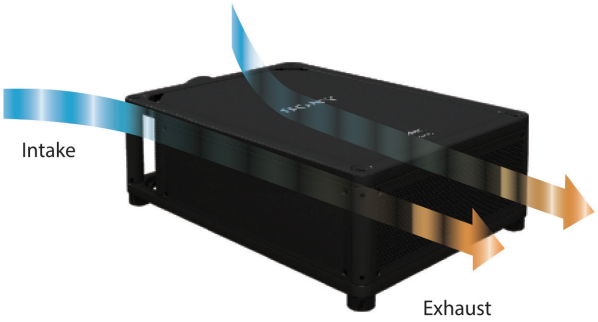
With 5,000 lumens, the VW5000ES pursues high-flying home theater performance. But the design is well grounded in practicality.

- **Stable.** The optical system is designed to deliver thousands of hours of operating life with almost zero maintenance, thanks to Sony's Z-PhosphorTM laser light source, sealed optics and a meticulously designed chassis.
- **Cool.** Liquid cooling, high-capacity fans and one-way airflow keep the projector operating in the thermal comfort zone. And there's no need for special ductwork to handle the exhaust.



Sony's liquid cooling system is extremely efficient at conducting heat away from the optical block.

- **Quiet.** You won't need to build a special enclosure or projection room to shield your audience from fan noise. Under normal operating conditions, acoustic noise is 30 to 35 dB. (Fan noise will vary depending on the environment and other operating conditions.)



Ample ventilation cools the projector effectively – and quietly.

Key technology #6:
Z-Phosphor laser light source

The world of video projection changed decisively at InfoComm 2013. That's when Sony introduced the world's first 3LCD laser projector, the VPL-FHZ55 industrial projector. Here was a combination of brightness, resolution, convenience and virtually no maintenance that the world had never seen before. The projector won accolades from independent reviewers, glowing endorsements from delighted owners and several of the industry's top awards.

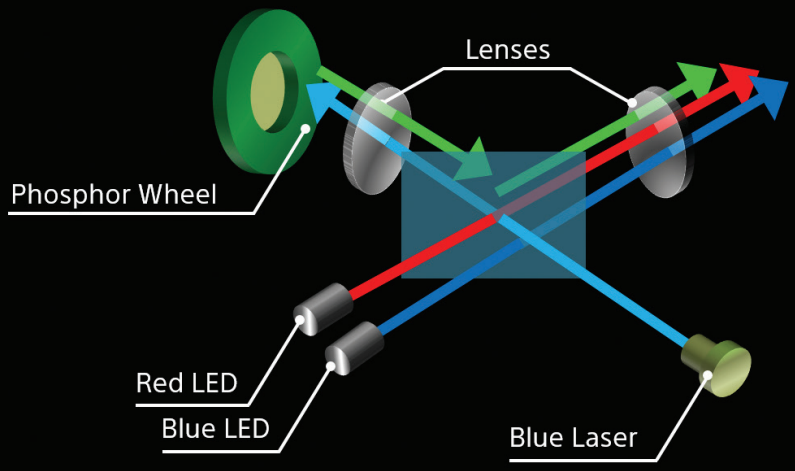
Types of lamp-free projection

Sony's Z-Phosphor™ laser light source is a breakthrough among lamp-free projection systems. In order to appreciate Sony's design in context, it helps to recognize the different classes of lamp-free projectors:

- **LED.** Generally, this is the most affordable, lowest-output type.
- **LED/laser hybrid.** A step up in performance and price, these use LEDs for some colors of light and a laser phosphor arrangement for others. As we will see, LEDs continue to impose performance limitations.
- **Laser phosphor.** A major step up, these projectors use laser light to excite a phosphor, which provides 100% of the illumination for the screen. Sony's VPL- FHZ55 Z-Phosphor projector was an early member of this group. But even compared to other laser phosphor models, Sony Z-Phosphor projectors stand apart for combining high resolution, high brightness and high color brightness.
- **Direct laser/phosphor hybrid.** The VPL-VW5000ES projector uses a combination of direct laser light in addition to light from a phosphor excited by laser. This approach also forms the foundation of two Z-Phosphor industrial projectors: Sony's VPL-GTZ280 and GTZ270.
- **Direct laser.** For the largest venues, some projectors have begun to use a direct laser system: Red, Green and Blue lasers that illuminate the screen without intermediary phosphors. In 2005, Sony created a 60,000-lumen RGB direct laser projection system, which we exhibited at the Aichi World Exposition, and we continue to develop direct laser technology. While these projectors have real benefits, important questions remain about price, "speckle" artifacts, physical installation requirements and return on investment.

The limitations of LEDs

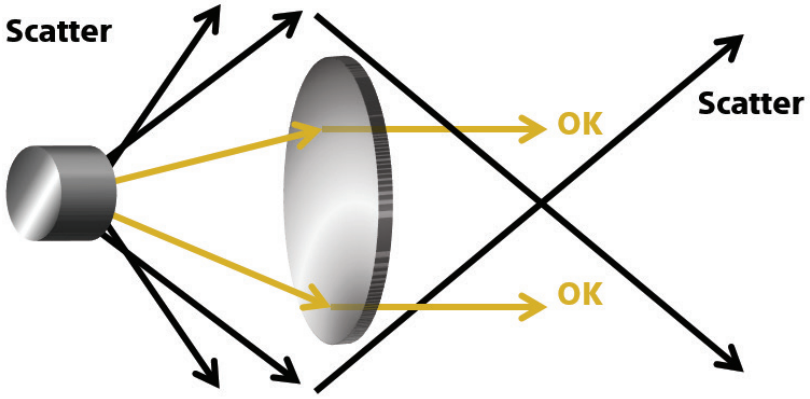
The advantages of Sony's Z-Phosphor design become clearer when we take a quick look at LED/laser hybrid technology. While individual models vary, one representative LED/laser hybrid design uses three light sources. A blue laser excites a rotating phosphor wheel to provide only the Green light. Red and Blue are provided via LEDs. While this arrangement does incorporate a laser and does eliminate the projection lamp, reliance on LEDs becomes a major limitation.



While LED/laser hybrid systems vary, this example is representative. Here the laser is responsible only for Green illumination. Red and Blue are handled by LEDs.

Compared to laser illumination, LEDs just aren't as bright. You might think it a simple matter to increase the brightness by increasing the LED driving power. However, this incurs reliability issues that may someday be resolved by further research and development. Until then, drive power remains limited.

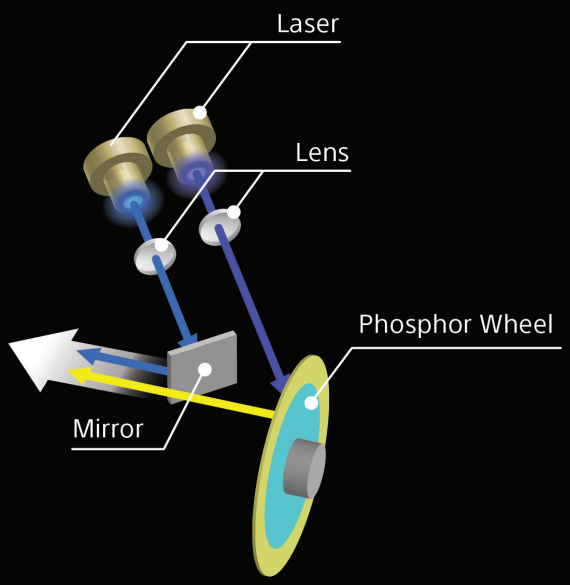
Alternately, you might try increasing brightness by using bigger LEDs or even multiple LEDs. Unfortunately, projection LEDs are already 1,000 times larger than projection lasers of equivalent brightness. The larger the light source, the more diffuse and difficult it is to channel toward the screen. Light tends to be wasted through scatter.



Sony's Z-Phosphor laser light source

Where LED/laser hybrid systems typically provide two out of three colors from LEDs, Sony's Z-Phosphor design starts with 100% laser light. And while other projectors can also make this claim, Sony stands alone, delivering a combination of end-user benefits that is unmatched.

As applied in the VPL-VW5000ES, the Z-Phosphor™ laser light engine provides separate paths for Blue and Yellow light. This system creates Blue by concentrating light from a miniature blue laser array even further via an aspheric lens and directing the blue light toward the screen. The system creates Yellow by reflecting light from a separate blue laser array off the phosphor wheel. A dichroic mirror then divides Yellow into Red and Green.



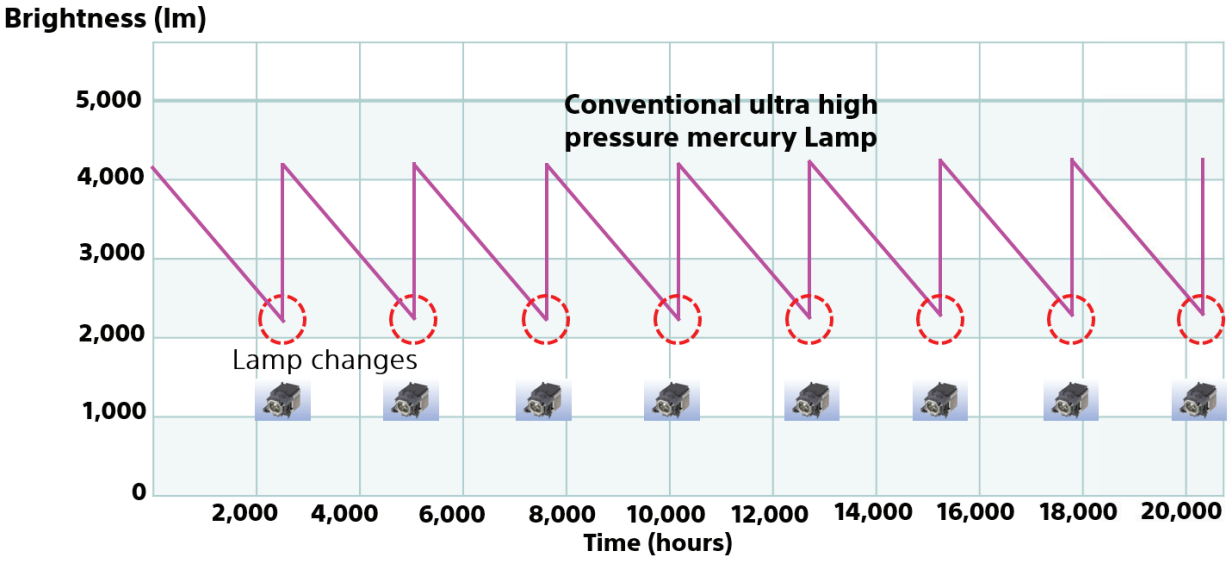
Sony's VPL-VW5000ES provides separate paths for Blue and Yellow light. This system projects Blue directly from the laser, while it creates Yellow by reflecting a laser off the phosphor wheel. No LEDs are needed.

Both the laser and the phosphor embody Sony's deep understanding of these technologies. For example, Sony Semiconductor began manufacturing lasers in 1986, becoming a leading supplier for the CD, DVD and game console markets. By 2010, we had shipped over 3 billion lasers. Our mastery of blue lasers extends to Blu-ray Disc™ players, PLAYSTATION® consoles and XDCAM® professional optical disc camcorders. We drew on this experience to build multiple blue lasers into an array roughly 1/1000 the size of an LED of equivalent brightness. Our laser array is highly redundant. So the failure of any single laser has negligible effect on output brightness. Because laser light is coherent, light scattering and waste are less significant. And the miniature size of the laser array reduces light scatter further still.

The phosphor is another unique formulation, based on decades of Sony experience with phosphor coatings in television and projection CRTs. The result is a complete projection system that can simultaneously achieve superb resolution and high brightness.

Up to 20,000 hours with virtually no maintenance

The ultra-high-pressure (UHP) mercury lamp inside conventional projectors is essentially a high-tech light bulb. And like more familiar light bulbs, it burns out, typically needing replacement every 1,500 to 3,000 hours. (Some of the latest lamps need replacement every 6,000 hours.) In dramatic contrast, Sony's Z-Phosphor™ laser light source is rated at 20,000 hours of life. That's equal to 10 hours a day, 5 days a week, 50 weeks a year for eight years. Projection with virtually no maintenance is a major advance for simplicity, convenience and peace of mind.



Conventional projectors incur the performance degradation of fluctuating light levels and variations in lamp color, not to mention the headache and cost of periodic lamp replacement.

Beyond maintenance headaches, conventional UHP mercury lamps yield inconsistent performance. As a UHP lamp ages, light levels tend to decline and color balance tends to shift. Sony's Z-Phosphor laser light source is far more consistent. The colorimetry of the laser system remains stable, while brightness will decrease somewhat over the years.

Up to 40,000 hours in Low Brightness Mode

For incredibly long life, the VPL-VW5000ES can even operate up to 40,000 hours in Sony's special Low Brightness Mode. (Conditions apply.) The long operating life speaks volumes not only for the stamina of the Z-Phosphor™ laser light source, but also for the durability of Sony's SXRD® microdisplay panels.

Worry free

Conventional projector lamps can fail, putting your entire home theater out of action. Sony's Z-Phosphor™ system drastically minimizes downtime. The blue laser light source is actually an array of multiple redundant lasers. This means that the failure of any individual laser is not a show-stopper.

Mercury free

The projector even has better chemistry. As the name implies, the ultra-high-pressure mercury lamp contains mercury, a poison. The Sony laser system is mercury free, a better choice for the environment.

Additional features: Picture quality

“Reality Creation” 4K upscaling

Sony understands that most of the content you’ll be watching will still originate in High Definition. That’s why we took special care in the HD-to-4K upscaling process. Simple upscalers interpolate the new pixels by taking the average of the two adjacent pixels. More sophisticated upscalers look at vertical, diagonal and horizontal neighboring pixels, plus the corresponding pixel on previous and following frames. Sony’s “Reality Creation” 4K upscaling does all of that, and much more.

- **Content-aware noise reduction.** The system starts by cleaning up the incoming signal with intelligent, content-aware noise reduction.
- **Pattern analysis.** Three-dimensional analysis recognizes patterns in the image.
- **“Reality Creation” database matching.** The actual picture patterns are compared to a large internal database of images.

The “Reality Creation” database is a vast portfolio of professionally shot images we’ve collected across more than a decade. They represent a range of subjects including people, landscapes, sea, sky, trees, clouds, flowers, sports and household objects.

Every pixel is matched with the most appropriate patterns in Sony’s vast database.

“Reality Creation” 4K upscaling can compare patterns in the original image with patterns in the database, match them up and actually replace original HD patterns with optimized 4K patterns. Thanks to this process, which goes far beyond interpolation, the VPL- VW5000ES can upscale HD to uniquely compelling 4K.

“Mastered in 4K” mode

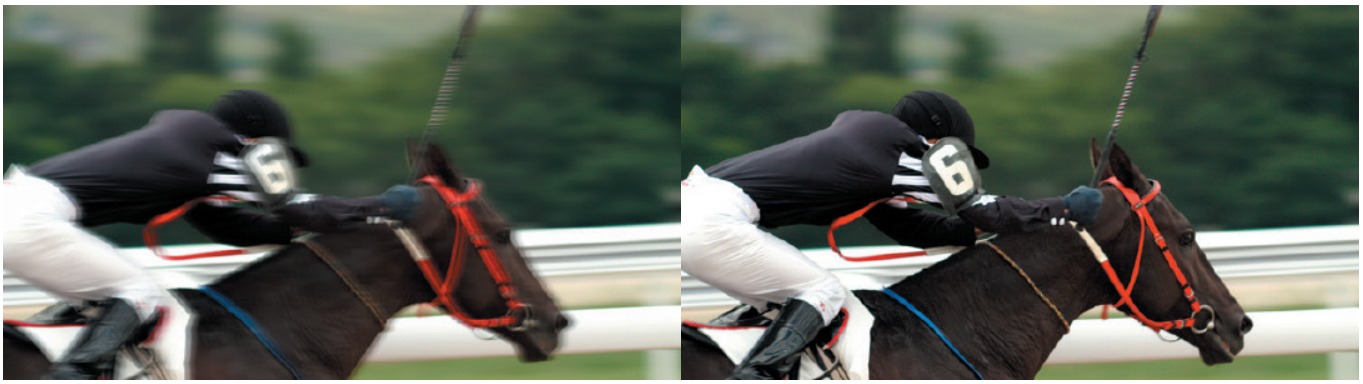
Since 2013, Sony Pictures Home Entertainment has offered a series of Blu-ray Disc™ titles with the designation “Mastered in 4K.” This mastering process preserves maximum resolution in the downconversion to HD. The discs themselves encode 24p movies with an enhanced bitrate and support the improved reproduction of the x.v.Color™ system. There’s one additional benefit. Sony knows the precise filter used to downconvert to HD in the mastering stage. So we can apply the same filter in reverse to upconvert to 4K in the projector.
The resulting image is as close as you can get to native 4K when starting from an HD source.

18 Gbps HDMI input

The VPL-VW5000ES accommodates a phenomenal range of input sources, input resolutions and input frame rates through a pair of HDMI 2.0 inputs, each capable of a maximum data rate of 18 Gigabits per second. The inputs also support HDCP 2.2 content protection. Maximum input resolution is 4096 x 2160 at frame rates of up to 60p with 4:4:4 color sampling at up to 8 bits or 4:2:2 color sampling up to 12 bits.

4K Motionflow® processing

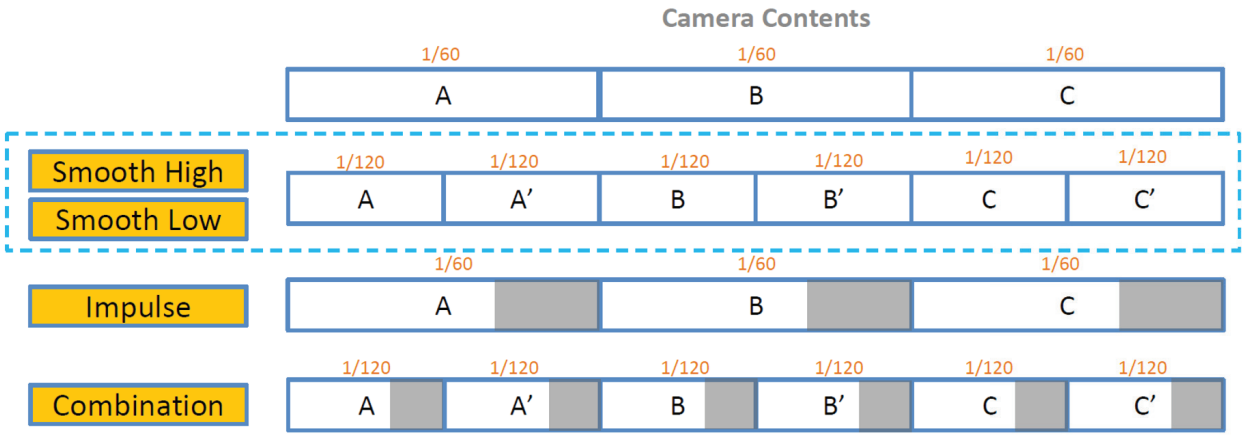
The VPL-VW5000ES incorporates a comprehensive solution to the issue of motion blur. A range of user settings gives discriminating viewers the ability to vanquish motion blur while respecting the artistic intent of movie and television directors and cinematographers.



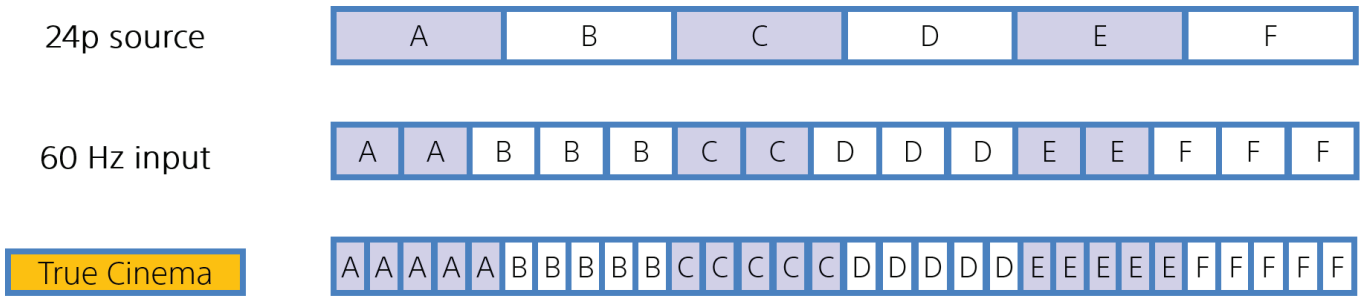
These simulated images suggest the effect of Motionflow processing, which yields substantially sharper rendition of moving subjects, ideal for TV sports.

The system provides five settings, each optimized for a specific range of content.

- **Smooth High.** Provides smoother motion, especially effective for film-based content. Converts 60 fps images into 120 fps, inserting new frames based on mathematical interpolation.
- **Smooth Low.** Provides smoother motion for standard use. Converts 60 fps images into 120 fps, inserting new frames based on mathematical interpolation.
- **Impulse.** Reproduces original picture quality. Provides cinema-like picture, which may flicker. Inserts a black interval between frames.
- **Combination.** Reduces motion blur while maintaining brightness for high-speed content. Converts 60 fps images into 120 fps, inserting new frames based on mathematical interpolation. Inserts a black interval between frames.
- **True Cinema.** Reverses the 3:2 pull-down process used to put 24p content into 60 Hz distribution channels. Restores correct 24p playback.
- **Off.** Displays content at original frame rates.



Smooth High and Smooth Low modes insert new, mathematically interpolated frames (A', B', C'). The Impulse mode inserts black intervals. The Combination mode does both.



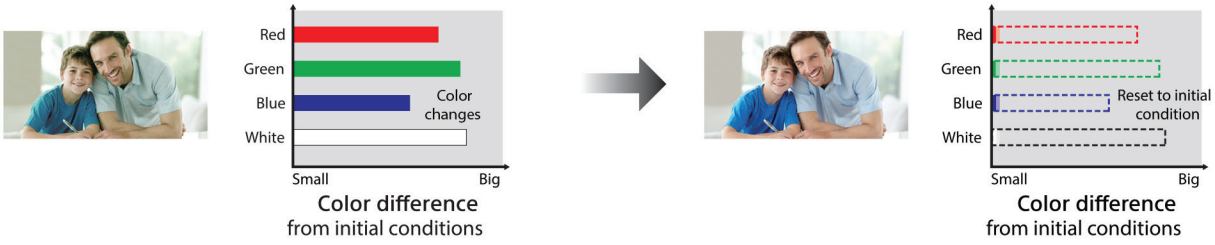
True Cinema mode reverses the 3:2 pull-down process required to convert 24p movies into 60 Hz video. So each movie frame appears for 1/24 second, as intended.

Low latency mode

The VPL-VW5000ES is filled with advanced digital picture processing. And some of these processes take several microseconds, a delay that engineers call “latency.” That’s hardly an issue when you’re watching movies and TV shows. But latency can be a real issue in gaming, where microseconds can make a difference. To support a first-rate gaming experience, Sony has implemented a special Low Latency mode. You get our fastest ever response time between your controller and the screen, for ultimate gaming action

Built-in Auto Calibration

The VPL-VW5000ES achieves exceptional color stability. To compensate for even slight drift in color reproduction over time, Sony provides Auto Calibration. This system uses a color sensor built into the projector to automatically reset the color to initial conditions. You can activate Auto Calibration in the Advanced Picture menu.



Panel alignment

The projector includes a Panel Alignment function for pinpoint spatial placement of the three colors – Red, Green and Blue. Panel Shift Alignment adjusts the whole picture across a ±3 pixel range in 0.1 pixel steps. To accommodate variations across the picture, Panel Zone Alignment adjusts any of 153 individual cross points over a ±3 pixel range, in 0.1 pixel steps.

3-year limited warranty

Rest assured that Sony has you covered. All of Sony’s Elevated Standard (ES) projectors enjoy three-year limited warranties, including a special tech support hotline in case you encounter any issues.

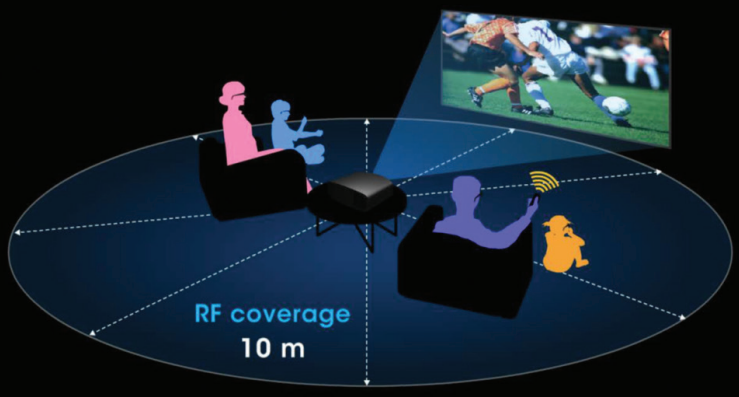
Other features: Ease of use

Wireless remote control

The projector includes a slim, straightforward remote control with back-illuminated keys for easy operation in a darkened room.

Built-in RF 3D transmitter

The VPL-VW5000ES supports 3D projection with a built-in radio frequency (RF) transmitter for active 3D glasses. The transmitter works with glasses up to 10 meters (33 feet) in any direction. Because there's no infrared receiving eye on the glasses, there's no need to maintain line-of-sight between transmitter and glasses. And RF transmission won't get tripped up by infrared remote controls.



The system conforms to the Full HD 3D Initiatives standard for active glasses and is compatible with most glasses that conform to that specification, including Sony's TDG- BT500A glasses, sold separately.

Picture position memory

As aspect ratios change, the projector can maximize the size of images on your screen via picture position memory. This memorizes the position of lens focus, zoom and shift for each aspect ratio, including 1.78:1 and 2.35:1. So you can store these settings in the projector for easy recall.

USB firmware updates

The capabilities of the VW5000ES aren't locked in when the projector ships from the factory. Firmware updates enable potential future improvements. Installers can download the updates from Sony's site, load them onto a USB memory drive and plug the drive into the projector to perform an update.

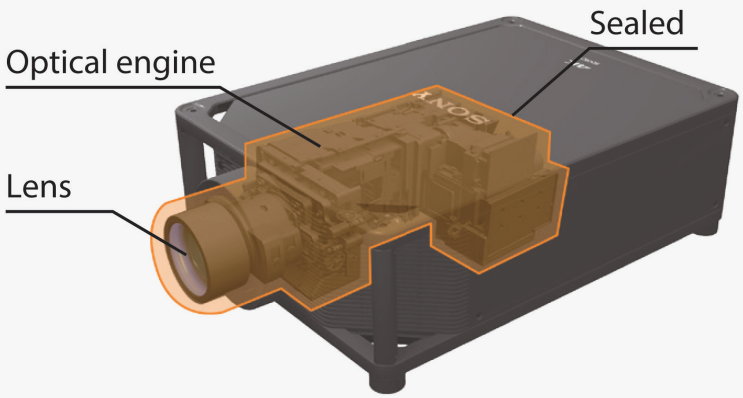
Low-noise operation

High-brightness projectors tend to run hot, which means their fans tend to run loud. To shield viewers from the noise, installations may require special enclosures or even a separate projection room. In addition, some projectors need special ductwork to vent the heated exhaust air away from the projector, adding further cost and complexity.

From the outset, Sony designed the VPL-VW5000ES to coexist comfortably in the same space as the viewer. Special liquid cooling is highly efficient. And the meticulous design of our one-way exhaust system enables very quiet operation. Acoustic noise ranges from 35 dB to a very quiet 30 dB. (Fan noise will vary depending on operating environment, operating conditions and operating mode.)

Dust resistant sealed optics

All optical components from lens to light source are sealed, avoiding dust accumulation.



Other features: Ease of installation

Color correction/color space adjustment

The on-screen display gives installers rapid access to color calibration. Installers can adjust HSV (Hue, Saturation, Value/Brightness) and select color space (BT.709, BT.2020, DCI, Adobe RGB, Color Space 1, Color Space 2, Color Space 3 and Custom).

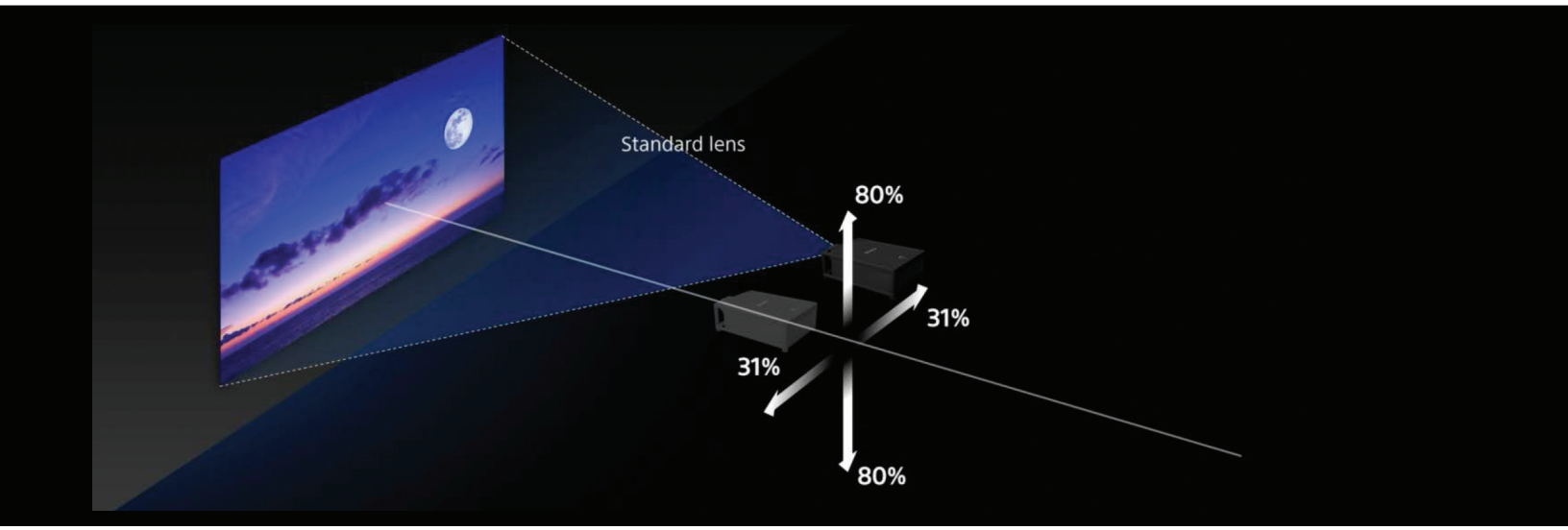
Control panel convenience light

Installers don't need to carry a flashlight up the ladder during installation. A built-in convenience light illuminates the control panel and inputs. When installation is done, a readily accessible switch turns the light off.

Wide throw ratio and lens shift

The supplied lens, Sony's VPLL-Z7013 accommodates a wide range of screen sizes and throw ratios. Throw ratios vary according to image aspect ratio. For 17:9 images, the throw ratio extends from 2.73:1 on the long end to 1.27:1. That's a zoom of about 2.1x. This means a 100" (2.54 m) diagonal picture can be projected at distances ranging from 9' 3" to 20' 1" (2.81 – 6.14 m).

The supplied lens also delivers a wide lens shift. So you don't need to place the projector exactly on the central axis of the screen. You can vertically shift the image up to 80% of the picture height, up or down, and horizontally up to 31% of the picture width, left or right.



For installations where space is at a premium, Sony offers the VPLL-Z7008 short throw lens, sold separately. It offers throw ratios from 0.8 to 1.0 (17:9 mode) and lens shift of ±50% vertical and ±18% horizontal.

High altitude mode

A special high altitude mode ensures proper operation at elevations from 5,000 to 10,000 feet (1,500 to 3,000 meters). This covers cities including Denver (5,100 feet), Albuquerque (5,300 feet), Mexico City (7,400 feet) and even Quito (9,400 feet).

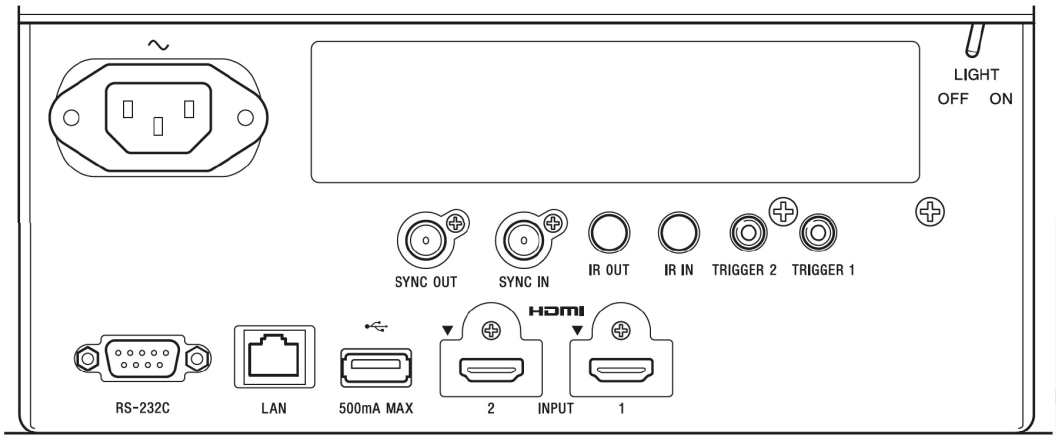
Multi-projector stack design

For redundant operation or passive glasses 3D, you can stack a pair of VPL-VW5000ES projectors, one on top of another. The feet of the top projector fit neatly into recesses in the bottom projector. You can also position two projectors side-by-side, flipping the second projector over on its back. To accommodate this configuration, you can remove and relocate the feet from the second projector.

Robust interfaces

In addition to the pair of HDMI inputs, the projector includes a complete set of control interfaces.

- RS-232C jack for remote control by home automation systems
- RJ-45 Ethernet port for remote control by home automation systems
- Sync In and Sync Out jacks for stacked projectors
- Trigger 1 and 2 interfaces for home automation control of curtains, room lighting, screens, masking and more
- IR in jack for connection to an external infrared remote control eye
- IR out jack for connection to an external infrared remote control repeater
- USB port for firmware updates



Powerful home automation

Sony understands that the VPL-VW5000ES is just one component in your home theater. That's why we built the projector to integrate well with leading third-party systems for home automation.

- Crestron Connected inside. The projector offers embedded Crestron® control intelligence. When connected via Ethernet, the projector operates as part of the native Crestron network. Using Crestron Fusion RV™ software, the projector can be seamlessly monitored, managed and controlled from any web-enabled laptop computer or mobile device.

- Control4 SDDP (Simple Device Discovery Protocol). The VPL-VW5000ES conforms to Control4's original protocol to enable simple device pairing to a Control4® automation system. Features include automatic device discovery, device identification with a unique identifier (not an IP address), automatic driver installation and the ability of devices to use DHCP IP addressing and still be uniquely identified.

- AMX Device Discovery
- Savant Partner in Excellence
- RTI
- URC

VPL-VW5000ES Specifications

Display System		4K SXRD panel, projection system
Display device	Size of effective display area	0.74" x 3
	Number of pixels	26,542,080 (4096 x 2160 x 3) pixels
Projection lens	Focus	Powered
	Zoom	Powered
	Lens shift	VPLL-Z7013 (Bundled): Powered, Vertical: +/-80%, Horizontal: +/-31% VPLL-Z7008 (Optional): Powered, Vertical: +/-50%, Horizontal: +/-18%
	Throw ratio	VPLL-Z7013 (Bundled): 1.27:1 to 2.73:1 VPLL-Z7008 (Optional): 0.80:1 to 1.02:1
	Screen size	VPLL-Z7013 (Bundled): 60" to 300" (1,524 mm to 7,620 mm) VPLL-Z7008 (Optional): 60" to 1000" (1,524 mm to 25,400 mm)
Light source		Laser diode array
Filter replacement cycle (Max.)		20,000 hours
Light output		5,000 lm
Color light output		5,000 lm
Contrast ratio		∞ : 1 (dynamic contrast)
Accepted digital signals		VGA, SVGA, XGA, WXGA (1280x768), Quad-VGA, SXGA 720x480/59.94p/60p, 720x576/50p 1280x720/50p/59.94p/60p, 1920x1080/50i/59.94i/60i 1920x1080/23.98p/24p/50p/59.94p/60p 3840x2160 /23.98p/24p/25p/29.97p/30p/50p/- 59.94p/60p 4096x2160/23.98p/24p/25p/ 29.97p/30p/50p/- 59.94p/60p
Color bit depth		Up to 12 bit via HDMI
INPUT OUTPUT (Computer / Video / Control)	HDMI1 / HDMI2	Digital (RGB/Y Pb/Cb Pr/Cr), both with HDCP 2.2 support
	Trigger1 / Trigger2	Minijack, DC 12 V Max. 100 mA
	Remote	RS-232C, D-sub 9-pin (female)
	LAN	RJ-45, 10BASE-T/100BASE-TX
	IR IN / OUT	IN: 1, Out: 1, Mini jack
	SYNC	IN: 1, Out: 1
	USB	Type A
On-Screen Display language		18 languages (English, Dutch, French, Italian, German, Spanish, Portuguese, Turkish, Russian, Swedish, Norwegian, Japanese, Simplified Chinese, Traditional Chinese, Korean, Thai, Arabic, Polish)
Acoustic noise		30 dB ~ 35 dB (Under normal environmental conditions. Acoustic noise will depend on the operating mode and environmental conditions.)
Operating temperature & humidity		41°F to 104°F (5°C to 40°C) / 20% to 80% (no condensation)
Storage temperature & humidity		14°F to +140°F (-10°C to +60°C) / 20% to 80% (no condensation)
Power requirements		AC 220 V to 240 V, 6 A, 50/60 Hz (For Europe and China) AC 100 V to 240 V, 12 A to 6 A, 50/60 Hz (For other countries)
Power consumption		1.2 kW maximum
Power consumption	Standby Mode	0.4 W (When "Remote Start" is set to "Off")
	Networked Standby Mode	0.6 W (LAN) (When "Remote Start" is set to "On")
Heat dissipation		4092 BTU/h
Dimensions	Excluding lens, protrusions	W 21-21/32 x H 8-31/32 x D 29-17/32 in (W 550 x H 228 x D 750 mm)
	Including bundled VPLL-Z7013	W 21-21/32 x H 10-5/16 x D 34-21/32 in (W 550 x H 262 x D 880 mm)
Weight	Excluding lens	Approx. 88 lbs. 3 oz. (40 kg)
	Including bundled VPLL-Z7013	Approx. 94 lbs. 13 oz. (43 kg)
Supplied accessories		VPLL-Z7013 standard zoom lens, RM-PJ24 Remote Commander, Size AA (R6) Batteries (2), AC Power Cord, Operating Instructions (CD-ROM), Quick Reference Manual
Optional accessories		VPLL-Z7008 short throw lens TDG-BT500A 3D glasses

Sony's lineup

	VPL-VW5000ES	VPL-VW1100ES	VPL-VW675ES	VPL-VW365ES
Resolution	Native 4K 4096 x 2160	Native 4K 4096 x 2160	Native 4K 4096 x 2160	Native 4K 4096 x 2160
Microdisplays	3 SXRD® chips	3 SXRD chips	3 SXRD chips	3 SXRD chips
Light Engine	Z-Phosphor™ system	Lamp	Lamp	Lamp
Brightness	5,000 lm	2,000 lm	1,800 lm	1,500 lm
Dynamic Contrast	∞:1	1,000,000:1	350,000:1	N/A
Reality Creation	4K	4K	4K	4K
Mastered in 4K mode	Yes	Yes	Yes	Yes
HDR	Yes	-	Yes	Yes
Recommended lamp cycle	20,000 hrs.	2,500 hrs.	6,000 hrs.	6,000 hrs.
Picture Position	Yes	Yes	Yes	-
Lens Shift (V)	±80%	±80%	±85%	±85%
Lens Shift (H)	±31%	±31%	±31%	±31%
Inputs	HDMI x2	HDMI x2, RGB, Component	HDMI x2	HDMI x2
Control interfaces	IR, Trigger, LAN, USB, 3D Sync, RS-232C	IR, Trigger, LAN, 3D Sync, RS- 232C	IR, Trigger, LAN, USB, RS-232C	IR, Trigger, LAN, USB, RS-232C
HDCP 2.2	Yes	Yes	Yes	Yes
Built-in Auto Calibration	Yes	-	Yes	-
3D	RF Built in	IR built in	RF built in	RF built in

	VPL-GTZ1	VPL-HW65ES	VPL-HW45ES	VPL-VZ1000ES
Resolution	Native 4K 4096 x 2160	Full HD 1920 x 1080	Full HD 1920 x 1080	Native 4K 4096 x 2160
Microdisplays	3 SXRD chips	3 SXRD chips	3 SXRD chips	3 SXRD chips
Light Engine	Z-Phosphor system	Lamp	Lamp	Z-Phosphor System
Brightness	2,000 lm	1,800 lm	1,800 lm	2,500 lm
Dynamic Contrast	∞:1	120,000:1	N/A	∞:1
Reality Creation	Super Resolution	Advanced	Advanced	4K
Mastered in 4K mode	-	-	-	yes
HDR	-	-	-	yes
Recommended lamp cycle	20,000 hrs.	6,000 hrs.	6,000 hrs.	20,000 hrs.
Picture Position	Zoom only	-	-	-
Lens Shift (V)	N/A	±71%	±71%	Install only
Lens Shift (H)	N/A	±25%	±25%	Install only
Inputs	HDMI x4	HDMI x2	HDMI x2	HDMI x4
Control interfaces	IR, LAN, USB, RS-232C	IR, Trigger, LAN, USB, RS-232C	USB, RS-232C, IR	IR, USB, LAN – RJ45, RS-232C
HDCP 2.2	Yes	-	-	Yes
Built-in Auto Calibration	Yes	-	-	Yes
3D	RF Built in	RF Built in	RF Built in	RF Built in

SONY

A final word

In this document, you'll find charts, diagrams and technical explanations. But you won't find the true benefit of the VPL-VW5000ES. You can only experience that benefit sitting comfortably in a suitably darkened room with a well-chosen HDR 4K source and the projector in action. Only then can you appreciate the full significance of Sony's achievement.

www.sonypremiumhome.com

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