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# Delivering the 2014 FIFA World Cup in 4K Ultra HD

Over 2,500 hours' worth of live match footage with 64 matches across two time zones.
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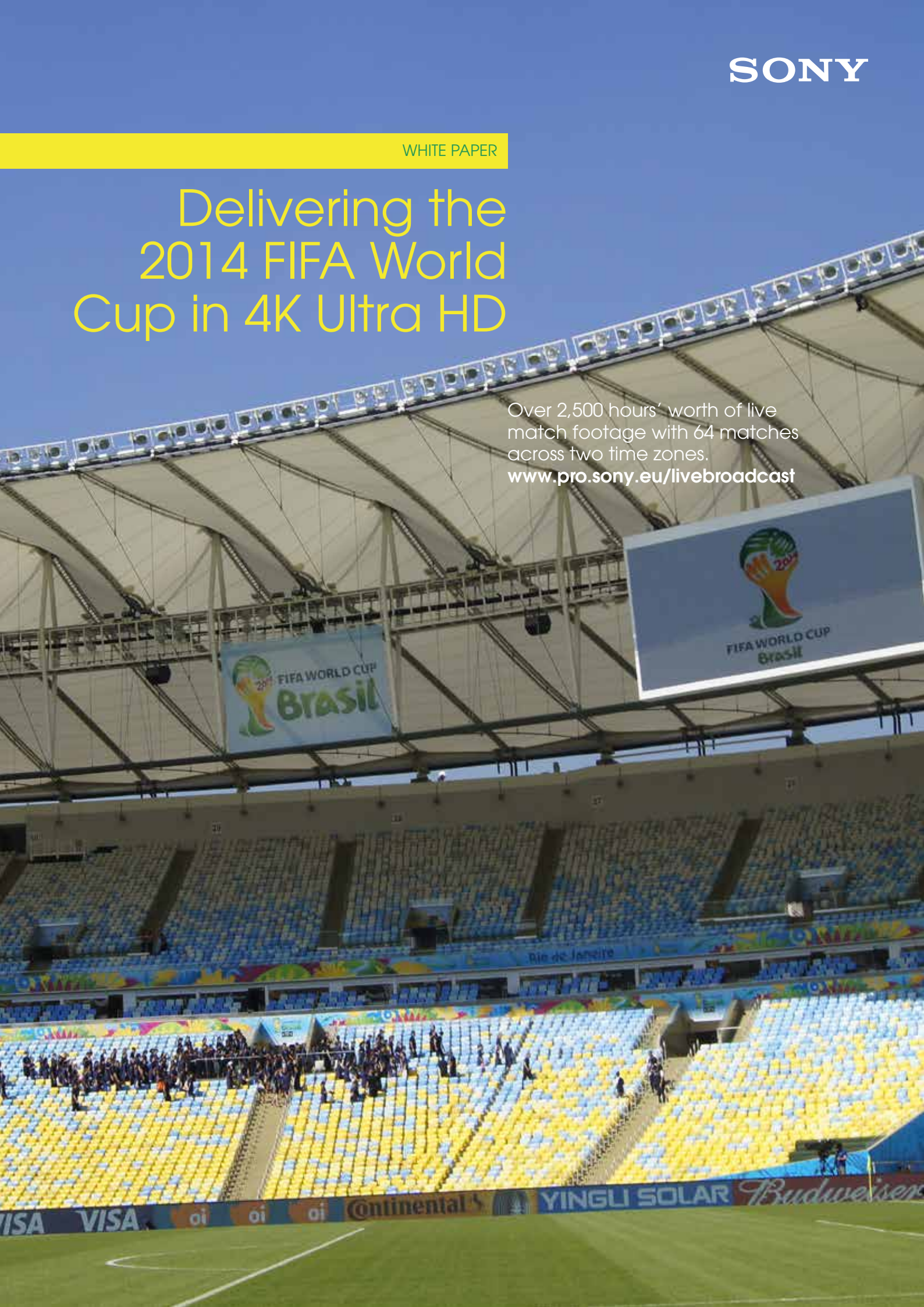



WHITE PAPER

# Delivering the 2014 FIFA World Cup in 4K Ultra HD

The 2014 FIFA World Cup™ in Brazil sees the next evolution in sports broadcasting, with the first ever 4K World Cup coverage.

A game-changer for live sports production, three matches – including one of the Quarter Final rounds and the Final – are being captured in live 4K, creating the most immersive, visually spectacular viewing experience sports fans have experienced yet.

Building on FIFA's and Sony's successful 4K trial at the FIFA Confederations Cup 2013 in Brazil, footage from three key games are being captured in detail-packed 4K Ultra HD. Providing a truly immersive viewing experience, 4K pictures from this summer's tournament are being offered to selected broadcasters and also distributed via retail stores, online and in cinemas.

## Facts & Figures

The technology being used to capture the 4K footage includes 12 PMW-F55 cameras to cover the matches in 4K, 1 F65 cameras with 2x speed 4K replays, 8 Chrosziel Aladin MKII broadcast lens control systems and a fully-featured 4K OB truck supplied by Globosat that includes the Sony MVS-8000X switcher, PWS-4400 servers, PVM-X300 4K TRIMASTER LCD monitors, 4K Bravia TVs, EVS XT3 servers and PSZ-HA1T hard disc drive storage. Half a million metres of cable is being used at the tournament. Sony is supplying 280 technical facilities staff to cover the event. Another 5 F55 cameras for shooting other 4K material during the event.

## Division of responsibilities

Working together, Sony and HBS (Host Broadcast Services) are responsible for the delivery of FIFA TV's 4K production in Brazil. Sony selected Brazilian outside broadcast and programming company Globosat (part of TV Globo Group), UK-based outside broadcast company Telegenic to provide the production platform and German lens quality specialist Chrosziel. Globosat is responsible for the provision of on-the-ground technical facilities, whilst Telegenic brings its technical expertise and experience, gained at the Confederations Cup 4K trial last year, to the project. Chrosziel provides the lens control systems and supports the team with lens and image quality specialists to maximise resulting image quality. The companies were chosen because of their reputation as innovators in their fields, bringing a wealth of expertise in live sports production and reputations for broadcast excellence. Fujinon is providing lenses for the 4K production.


Telegenic's pedigree in delivering high-profile, live and sporting events is proven and undeniable. Sony has a long-standing relationship with Telegenic having built multiple trucks together in the past eight years which have been used to deliver some of the world's largest live events in HD and 3D, from the FIFA World Cup to the Champions League Final and Confederations Cup. Having worked together to revolutionise the live production process and deliver new formats to market, most recently at 4K live trials at the Confederations Cup, Telegenic was a natural partner to deliver the production and 4K expertise for this project. Globosat runs channels and specialises in sports, particularly football, giving them a vast amount of experience in live sports broadcasting and a robust technical infrastructure to support that. The company has a pedigree in the Brazilian market, as Telegenic have in Europe, and bring with them a wealth of sports broadcasting expertise, strong technical facilities and an expert crew.

Chrosziel has an expertise of over 40 years in the field of optical lens control, lens and camera support, lens testing and servicing. Tailored products and services are continuously being developed, working closely with Sony and professional users.


## 4K distribution

Sony and FIFA are collaborating on a range of 4K initiatives at the event, including production of the Official 2014 FIFA World Cup Film in 4K Ultra HD, and the production of three full matches in 4K to further promote the growth of 4K content. The Official 4K Film includes a selection of games, including the final, and is due to be distributed online by FIFA via 4K content distribution services after the event finishes.

FIFA is also leveraging Sony' s professional 4K equipment within its 4K live production workflow processes at the event to film one match from the round of 16 (to be held on 28 June), one quarter-final (on 4 July), and the final (on 13 July) at the Estadio do Maracanã in Rio de Janeiro. Sony's products and solutions including its CineAlta 4K live camera PMW-F55, 4K multi-port AV storage unit PWS-4400, 4K LCD monitor PVM-X300, and 4K multi-format switcher MVS-8000X are being used to film the event. At Sony's commercial display booths located within some of the venues and at the FIFA-hosted HD public viewing "FIFA Fan Fest™" events to be held in Brazil, visitors can enjoy Official 4K Film promotional trailers produced in 4K/60P with match action. Footage is also being distributed to retail stores for viewing in around 30,000 locations.

## 4K technology

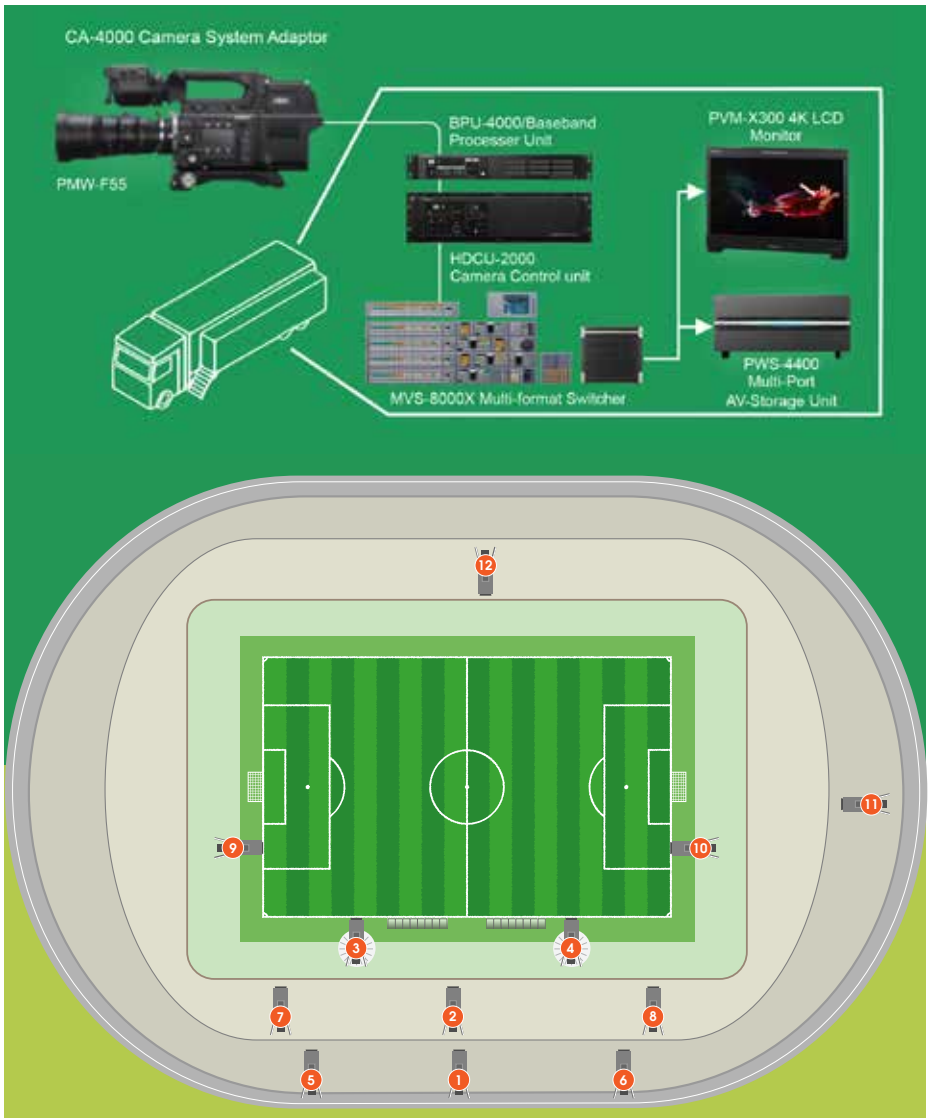
Over the past few years, Sony has worked incredibly closely with FIFA and HBS to push the boundaries of live production at events including the Confederations Cup, where live 4K was trialled, and the 2010 FIFA World Cup, where 25 matches were filmed in live 3D. Sony continues to develop key products in the 4K production chain, and now offers a live camera system with an efficient workflow from shooting to viewing.

Sony's 4K live camera system consists of a CA-4000 camera system adaptor attached to the docking interface of the F55 4K camera, along with a BPU-4000 baseband processor unit and an existing HDCU-2000/HDCU-2500 camera control unit connected by optical fibre cable. Using the HDCU-2000/HDCU-2500 means that this system can be powered through standard SMPTE fibre cable. This also means that real-time fine adjustment of image factors and various other camera settings can be made with Sony's RCP-1500 Series remote control panels or MSU-1000 and MSU-1500 Series master setup units. The CA-4000 adaptor provides essential functionalities required for live production, including Tally, Intercom, Lens Control Interface, Audio channels, and a viewfinder interface. Other products make-up a complete 4K live production workflow, including a multi-port server capable of 4K and HD recording, a multi-format switcher capable of real-time 4K signal processing, and a 4K LCD monitor.

## 4K production plan

The 4K production in Brazil uses 13 4K cameras to capture the three matches from the round of 16, one quarter-final and the final, all from the Estadio do Maracanã in Rio. Sony is providing extensive technical support to FIFA, including the development of a 4K live production system. The three 4K matches have been carefully selected to showcase live 4K footage as beautifully as possible without impacting the HD production, which is supplying match coverage for broadcasters around the globe. The crew of around 40 are a mixture of Telegenic and Globosat personnel, so there are both local and UK crew members. Chrosziel provides an image control quality specialist from Germany. From a picture standpoint, the video production for HD and 4K are treated completely separately. The audio will be interlinked and for the 4K matches, we will take the stadium sounds from the HD production but include special commentary for the 4K footage.

UK director Ben Miller is directing all three of the 4K match productions on behalf of HBS. Sony has previously worked with Ben in a 4K sports production environment at both the Confederations Cup live trials and at Wimbledon. Naturally there are different production values for 4K that require a different style of shooting to HD. Wider, panning shots taken lower down are the killer shots for 4K. When shooting in 4K, the depth of field is shallower and there's therefore a need to pull focus much more often, making it more challenging for cameramen to capture this footage. In addition to the 4K feeds, the team has access to other HD cameras in the stadium being used for the HD match coverage. These include Cablecam, a camera position suspended on a system of ropes and pulleys above the match pitch, and Helicam, supplied from a helicopter over the stadium.




**1.** Main Camera
**2.** Main Close Up
**3.** Pitch Level Bench Left
**4.** Pitch Level Bench Right
**5.** 16m High Left
**6.** 16m High Right
**7.** 6m Left
**8.** 6m Right
**9.** Near Side Goal Left
**10.** Near Side Goal Right
**11.** High Behind Goal Right
**12.** Reverse Mid High

## 4K lenses and lens control

Because 4K coverage is subtly different from HD coverage, it requires good cameramen and directors to know how to get the best out of the 4K cameras and lenses. The camera rendering is different in 4K to HD, due to the higher resolution and the immersive path of 4K.

All the 4K lenses at the World Cup are Fujinon Cabrio or HK Premier range of lenses. Sony is using the following 4K HK Premier range of lenses for the 2014 FIFA World Cup: 4 x HK75-400mm, 4 x HK24-180mm and 4 x ZK85-300mm Cabrio. Fujinon's PL-mount lenses have been established as one of the main choices for 35mm cinematic and TV broadcast productions. This class of optical lens technology offers 4K and 4K+ ultimate optical performance (+ above 4K) resolution with consistent T. No stops, colour matching and a natural bokeh thanks to the rounded nine blade iris technology. FIFA Films have hired 5 x ZK19-90mm Cabrio, 5 x ZK85-300mm Cabrio and 2 x ZK14-35mm Cabrio from Top-Teks in the UK. Cabrio lenses have a detachable zoom drive on the side. They also have a number of Sony Prime Lens packs.

Eight Sony PMW-F55 attached to the CA-4000 are mounted onto the Chrosziel 19mm Universal Lens Support Kit. The kit provides the lens support for the Fujinon HK Premier lenses via 19mm rods to take off the load from the cameras PL-mount. Additionally, the 19mm rods serve as the professional mounting device for the external standard lens decoder motors for Focus, iris and Zoom control. The motors are controlled by the Chrosziel Aladin MK II Broadcast Basic Setup Kit, which is connected to the camera via the standard lens connector of the CA-4000 and powered via the Sony SKC-PB40 power booster. Standard broadcast focus and zoom demands are directly attached to this lens control system. Via this configuration, the image technician is able to control the iris directly from the Sony RCP, can read out the precise value of the T-Stop of the iris lens motor and has access to the zoom and focus position. The camera operator can work in his favoured workflow by, for example, controlling VTR and the video return signals of the camera from the zoom demand, or using different zoom speeds.

For maximising the image quality, one Chrosziel Aladin Focus and iris hand unit is installed in the OB vehicle. The iris of this hand unit can be routed to the zoom motor of any camera with a Chrosziel Aladin MKII receiver. Via this hand unit, the image technician can access the focus and zoom of the lens at any time from the OB vehicle. This is especially critical for the 4K productions to check the back focus with the Sony 4K production monitor. No camera operator is needed during this important control step, saving critical time and manpower.

Before you start thinking about 4K there's a serious consideration to take into account when it comes to 4K cameras versus 'normal' cameras. 4K cameras are single-chip models, whereas broadcast cameras have 3CCD blocks (Red, Green and Blue) and the image is more sensitive to depth of field. It's much more straightforward to get a far greater depth of field with a broadcast camera, compared to a 4K camera. Depth of field is related to the amount of light and the control of the iris, and, some learning needs to be done around single sensor cameras to create a similar effect. The camera operator and the producer/director needs to be aware of what to do (with a single sensor 4K camera) in terms of managing lenses, focus and exposure, to create a similar depth of field to a broadcast camera. It's certainly not impossible to emulate the depth of field of a three-chip broadcast camera with the F55, though, it's just a skill that needs to be learned. If you were shooting with a single-chip HD camera you'd struggle to get a look as good as with a three-chip camera. But 4K cameras are a lot more sensitive, providing more F-stops, so you can adjust the exposure, iris, lenses and other tools available on the camera to adjust the imagery. For this, the Chrosziel Aladin MK II Broadcast Lens Control System returns the exact current iris value to the RCP to support the image technician.


## Audio production plan

The 4K coverage is taking the audio from the HBS HD match coverage, with additional 4K commentary. Key elements of the audio production plan were successfully implemented during the 2010 FIFA World Cup™ in South Africa. The HBS-designed improved Audio Production Plan, based on 2010, was recently successfully tested and is being implemented in 2014. The Audio Production Plan includes Stereo Television International Sound (TVIS), Stereo Radio International Sound (RIS), 5.1 Surround Multi-Channel International Sound (MCIS) and Multi-Feed Audio Content.

## Equipment supply and testing

The 4K coverage includes 12 PMW-F55 cameras, 1 F65 camera with 2x speed 4K replays, 8 Chrosziel Aladin MKII Broadcast Lens Control Systems and a fully-featured 4K OB truck supplied by Globosat that includes the Sony MVS-8000X switcher, PWS-4400 servers, PVM-X300 4K TRIMASTER LCD monitors, 4K Bravia TVs, EVS XT3 servers and PSZ-HA1T hard disc drive storage. All the equipment has been quality-checked to ensure it is set-up in the exactly the same way. This work has been conducted at Telegenic's headquarters in Europe.

## Post production in 4K

Quantel has supplied a Genetic Engineering 2 (GE2) system for Sony's 4K installation at the HBS production facility at the FIFA World Cup in Brazil. The Quantel GE2 system, which includes two Pablo Rio 4KO colour correction and finishing systems sharing storage and workflow via a GenePool, is being used for the production of fast-turnaround 4K highlights packages. The Quantel system is also being used for the post production of the Official FIFA World Cup film in 4K Ultra HD.

Pablo Rio is Quantel's high quality colour and finishing system that provides the ultimate productive workflow for 2D and S3D projects. Pablo Rio runs on high performance PC hardware and exploits NVIDIA Maximus multi-GPU technology to deliver interactivity and maximum productivity. The GE2 system provides shared storage and workflow for up to four Pablo Rio systems, providing better team-working and more productive post.

4K 60p XAVC recorded on the F55 cameras at three matches played at the Maracana Stadium in Rio de Janeiro are instantly available for viewing and editing on the Pablo Rio colour and finishing systems thanks to their ability to begin work immediately with soft-mounted media without transcoding. The Pablo Rios are also equipped with Fraunhofer IIS's integrated easyDCP toolset for production of cinema deliverables.


## PMW-F55 4K camera

The PMW-F55 incorporates a Super 35mm 4K CMOS image sensor and accepts a PL-mount lens as well as a B4-mount lens with an LA-FZB2 mount adaptor. The camera delivers multiple shooting options for HD/2K/QFHD/4K, and pristine image quality. Its modular style allows for a wide range of configurations to meet a large variety of user needs. In combination with the CA-4000, BPU-4000, and HDCU-2000/2500, the user can achieve a powerful 4K live camera system.

## Chrosziel Aladin MKII Broadcast Lens Control System

The latest Aladin MK II controls focus, zoom and iris of PL-mount, ENG and similar lenses via standard external motors or internal lens decoder motors. Camera functions like video return and talkback switching, focus / iris / zoom follow, digital RCP read out and tally are supported. The camera operator's common remote demands are used for focus, zoom, video return and talkback operation. Adapter cables and wireless controls are available for crane, SteadiCam, helicopter and similar applications. RCP control from the OB vehicle or serial control by the Chrosziel Aladin iris hand control slider is used to control the iris. The lens motors can be controlled via standard lens control equipment, serial RS connection (via fibre adaptors or serial cable), BNC connection or wireless. The Aladin MK II can be powered via the power outlet of the CA-4000 fibre adaptor of the F55 and F65 camera. Remote camera start / stop control is supported via broadcast zoom demands or Aladin hand controller.

## BPU-4000 Baseband Processor Unit

The BPU-4000 offers real-time 4K digital signal processing and the signal can be simultaneously down-converted to a HD signal and output when the CA-4000 is attached to the PMW-F55 via an optical fibre cable. The detail process can be optimally adjusted in each signal. The BPU-4000 features parallel processors for 4K/HD, a down-convertor from 4K to HD and HD cut-out and HD High Fame Rate (HFR) operation by installing optional software (the SZC-2001 is required for the HD cut-out function; SZC-2002 for the HFR function).

## CA-4000 Camera System Adaptor

When the CA-4000 is attached to the PMW-F55, it works as a 4K live camera in combination with the BPU-4000 and HDCU-2000/HDCU-2500. The CA-4000 sends 4K data to the BPU-4000 via a SMPTE fibre cable, supports camera system operations (Intercom, Tally, and Return), picture adjustment functions are the same as those of HDC Series cameras, the HD prompter is supported by independent digital data from the HDCU-2000/2500 and you can use a USB connector for quick menu setup. It is also possible to supply power to accessories such as a large lens by attaching an SKC-PB40 camera power boost kit to the CA-4000.

## HDCU-2000 and HDCU-2500 Camera Control Units

The full-rack-size HDCU-2000 and half-rack-size HDCU-2500 are available for the 4K live camera system. These enable power supply to the camera, interfacing with peripheral equipment, and transferring Intercom, Tally, Prompter, Audio, and other signals. The optical fibre transmission system used in these units maintains the camera's high picture quality. Even without an HDCU-2000/HDCU-2500 unit, the 4K live camera system can operate by supplying power to the PMW-F55/CA-4000 locally in a simple configuration.

## F65 4K live camera

Sony's F65-based 4K Live Camera System with the combination of the PWS-4400, 4K/HD live server adds a new level of expression to live production, with its high-frame ability to shoot and record 4K 120p slow-motion images. To make use of a 4K Live Camera System based on the F55 launched last year, a new adaptor exclusively for the F65 has been designed.

## PWS-4400 server

The PWS-4400 XAVC server records both 4K and HD video and can be configured for up to four recording channels. The unit provides 2TB internal storage as standard (and up to 8TB as an option), which provides around 5 hours storage @ 4K 50p/59.94p 600Mbps through the very efficient XAVC video format. In the 4K workflow, the unit generates a 4K XAVC file that can be handled easily in non-linear editing systems (NLE).

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